Measuring Fiscal space available in Algeria: An ARDL Approach

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Received: 26/05/2025; **Revised:** 03/07/2025; **Accepted:** 14/09/2025

Summary: This study assesses the fiscal space available in Algeria from 1990 to 2022, with a focus on understanding the government's ability to implement fiscal policy without compromising financial sustainability. Given Algeria's heavy dependence on oil revenues, the analysis explores the country's vulnerability to external shocks and its capacity for fiscal maneuvering. The research employs the ARDL approach using quarterly interpolated data and applies three models: Bohn's fiscal reaction function and two specifications based on Ostry et al.'s fiscal fatigue framework. The empirical findings confirm the existence of a long-term relationship between the primary budget balance and public debt, with evidence of fiscal fatigue indicated by the negative cubic debt coefficient. The estimated fiscal space is limited, at only 0.10% of GDP, with the debt threshold reaching 62.9%. These results suggest Algeria lacks sufficient space for expansionary fiscal policies. The study's novelty lies in being the first to apply this modeling framework to Algeria, offering a robust and context-specific measurement of fiscal space. Practically, it provides essential insights for policymakers on the risks of excessive debt and highlights the need for structural reforms, revenue diversification, and prudent fiscal management to ensure long-term economic stability and resilience.
Keywords: fiscal reaction function, fiscal fatigue, fiscal space, ARDL Model.
Jel Classification Codes : E62 ; H62 ; H63 ; H39

I- Introduction :

The notion of fiscal space has garnered increasing interest in academic and policy domains, particularly following global crises that have burdened public budgets in several developing nations. Fiscal space, as defined by Heller (2005), refers to the government's capacity to increase expenditure or decrease taxes without jeopardizing fiscal sustainability, illustrating the equilibrium between public policy objectives and long-term debt limitations. The necessity of assessing fiscal space has intensified due to rising public debt and greater susceptibility to external shocks (Ostry et al., 2010; Ghosh et al., 2013).

Algeria serves as a significant instance for analyzing fiscal space owing to its unique macroeconomic framework. In a hydrocarbon-dependent economy, oil and gas earnings provideover 90% of exports and over 60% of budget revenues (Bank of Algeria, 2021).

This significant dependence on fluctuating international oil prices exposes the budgetary situation to recurrent external shocks, as seen by the oil price crash of 2014 and the COVID-19 epidemic. Additionally, the nation has structural obstacles, including fragile non-oil tax bases, a substantial informal economy, and restricted economic diversification (Chibi et al., 2022), all of which constrain the government's budgetary flexibility.

These characteristics make Algeria a compelling case study for assessing fiscal sustainability under constraints. This research seeks to measure Algeria's fiscal space over the period 1990–2022 using the fiscal reaction function approach developed by Bohn (1998) and the fiscal fatigue framework proposed by Ostry et al. (2010). By applying the ARDL methodology to quarterly interpolated data, the study aims to provide empirical evidence on the country's capacity to maintain fiscal stability while accommodating development needs.

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I-1 Research Problem:

Notwithstanding the expanding literature on fiscal space and debt sustainability, empirical research concerning resource-dependent emerging economies, especially in North Africa, remains scarce. Algeria exhibits a distinctive situation characterized by a significant reliance on hydrocarbon income, persistent budget deficits, and escalating public debt, all of which heighten apprehensions over the government's ability to uphold fiscal sustainability. The fundamental issue is to comprehending how Algeria's fiscal stance reacts to debt buildup and if the nation possesses substantial budgetary capacity to address future shocks without jeopardizing macroeconomic stability.

I-2 Research Focus

This analysis examines the fiscal space in Algeria from 1990 to 2022, highlighting the sensitivity of the primary budget balance to fluctuations in public debt. It examines the problem of fiscal fatigue—a decline in fiscal responsiveness at elevated debt levels—and analyzes the influence of critical macroeconomic variables, including oil prices, inflation, and population growth, on fiscal outcomes.

I-3 Research Aim and Research Questions

The primary aim of this study is to evaluate the existence and extent of fiscal space in Algeria and to determine whether fiscal policy remains sustainable in the long term under conditions of rising public debt and economic volatility. The research aims to answer the following questions:

1. To what extent does Algeria possess fiscal space to implement countercyclical fiscal policies without endangering debt sustainability?
2. How does the primary budget balance respond to increases in public debt over time?
3. Is there empirical evidence of fiscal fatigue in Algeria?
4. What are the long- and short-term effects of key macroeconomic variables (e.g., oil prices, inflation, population growth) on fiscal sustainability?

II-Literature review :

The concept of fiscal space has been widely discussed in economic literature, particularly in relation to debt sustainability and fiscal policy effectiveness. Heller (2005a, 2005b) first defined fiscal space as the budgetary room that allows governments to undertake spending without compromising fiscal sustainability. Within this framework, "budgetary room" reflects a government’s capacity to reallocate resources effectively, while "fiscal sustainability" implies the ability to manage debt responsibly over time.

Several scholars have expanded on this foundation. Brun et al. (2006) emphasized fiscal space as a tool for fostering growth in developing countries, highlighting its role in addressing macroeconomic challenges. Perotti (2007) offered a more restrictive view, linking fiscal space to constraints on budget resources rather than their availability. Ley (2009) defined fiscal space as the budgetary resources available for growth-enhancing investments, without undermining economic stability. Similarly, Schick (2009) presented fiscal space as the financial flexibility required to fund new policy initiatives, aligning closely with Heller’s earlier definitions.

Ostry et al. (2010), on the other hand, connected fiscal space to debt sustainability by defining it as the difference between the current debt level and the debt threshold beyond which fiscal policy becomes unsustainable. Park (2012) viewed fiscal space as the financial gap between current tax collections and the Laffer curve peak; Aizenman and Jinjarak (2011) suggested the idea of "effective fiscal space," linked to a government's ability to repay debt under revenue pressure. Eller et al. (2011) stressed how fiscal freedom lets politicians respond to cyclical stocks and yet maintain systematic financial resilience.

Although these researches have increased theoretical understanding of fiscal space, many methodological gaps still exist. Many rely on linear models that ignore the non-linear dynamics of fiscal behavior at high debt levels—a problem addressed by Ghosh et al. (2013), who suggested the concept of "fiscal fatigue." Over time, the main balance's sensitivity to rising debt decreases, ultimately undermining fiscal stability.

Moreover, most of the earlier research has focused on advanced or growing economies, often overlooking the specific challenges faced by resource-dependent developing countries like Algeria. Among these include high reliance on oil earnings, poor tax bases outside the hydrocarbon industry, and vulnerability to external shocks. Moreover, few studies have employed time series approaches able to handle micro samples and mixed-order integration—a deficit the ARDL methodology can assist to address.

This research consequently aims to address this gap by evaluating Algeria's fiscal space from 1990 to 2022, stressing how the primary budget balance reacts to increasing debt levels. The study is the first application of the ARDL model in this context using a three-model approach: the first adopts Bohn's (1998) fiscal reaction function, while the second and third apply the fiscal fatigue framework developed by Ostry et al. (2010) to assess public debt limits and the non-linear dynamics of fiscal sustainability. This analytical paradigm allows for a more detailed and context-sensitive assessment of Algeria's actual budgetary maneuvering capabilities.

III-Theoretical Underpinning:

III-1 fiscal space

The purpose of having fiscal space is to provide the government with the flexibility to respond to changes in the economic and social environment, such as recessions, natural disasters, climate change, health epidemics, and demographic shifts. To achieve this, governments use countercyclical fiscal policies to stimulate demand, protect vulnerable populations, and establish critical infrastructure and institutions that support sustainable growth and development. These necessities, as confirmed by various studies, form the core essence of fiscal space. For further reading, see the study by (Roy, et al., 2007, pp. 1-38).

Furthermore, the scope of fiscal space extends to enhancing the credibility and predictability of fiscal policies, translating into mitigating risk premiums associated with government debt and instilling steady confidence in investors and international partners. Through wise and effective use of fiscal space, governments can affirm their steadfast commitment to fiscal prudence, transparency, and accountability, laying the foundation for enhancing economic stability. Additionally, fiscal space goes beyond economic dimensions and extends to its effectiveness in addressing a wide range of social and environmental challenges. These include areas such as poverty, inequality, climate adaptation, and gender equality, and involve the organization of necessary resources and the implementation of smart policies and programs. Fiscal space emerges as a conduit for expressing the aspirations of sustainable development goals. It facilitates investments in vital areas such as education, healthcare, infrastructure, and innovation, ensuring equitable access to public goods and services that enrich all levels of society. (Ostry, et al., 2010, pp. 1-24).

III-2 Calculating the fiscal space in Algeria

Some authors such as (Aguzzoni, 2011) view fiscal space essentially as a reframing of the broader concept of budgetary constraints and public financial sustainability (temporal constraint of the budget and public financial sustainability). Equation (1-I) represents this perspective:

$$D_t = D_{t-1} + i_t D_{t-1} - PB_t \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

- D_t: is the public debt, i_t:is the nominal interest rate on government bonds.
- PB_t: is the primary budget balance.

To calculate fiscal space in Algeria during the period of 1990-2022, we will use the method outlined by the World Bank (2020), which involves calculating the Required Primary

Balance for Debt Stabilization. This balance aims to stabilize the debt-to-GDP ratio each year. The calculation will be performed according to the following equation:

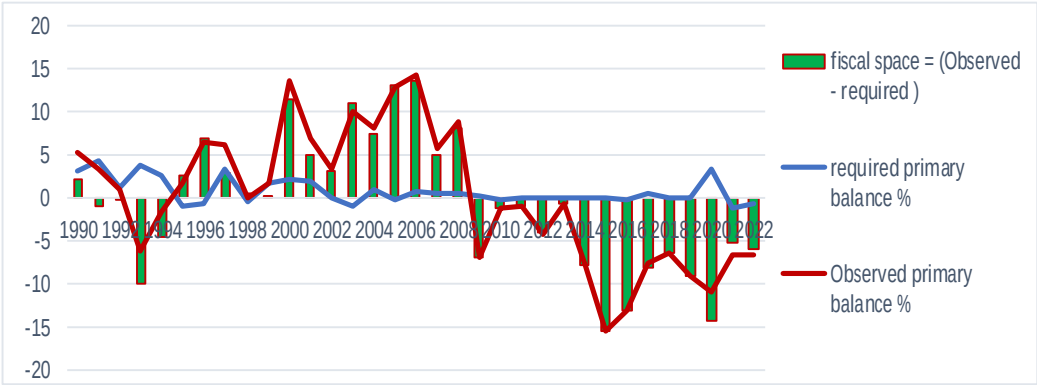
$$pb_t = \left[\frac{1+r_t}{1+g_t} - 1\right] d_{t-1} \text{.....(2)}$$

Where:

- pb_t: represents the required primary balance.
- d_{t-1}: is the ratio of public debt for the previous period.
- :g_t denotes the economic growth rate.
- r_t indicates the interest rate on public debt.

A positive fiscal space indicates that the financial situation **is better than required**, suggesting room for expansionary fiscal policies. Conversely, a negative fiscal space means that the observed financial situation **does not meet the required** level for achieving financial sustainability.

Figure 1: Results of calculating fiscal space in Algeria (1990-2022)



Source: From the researcher's calculation based on International Monetary Fund data, available at the following link: https://www.imf.org/external/datamapper/datasets/FM

Through Figure (1), it can be observed that in 1990, Algeria achieved an actual fiscal balance that exceeded the required balance, resulting in a positive fiscal space of approximately 2.22%. However, this positive fiscal space rapidly diminished, reaching a negative value of about -5.93% in 2022. Throughout this timeframe, the required balance, necessary for debt stability, initially showed a slight surplus but fluctuated between periods of decline and recovery. These fluctuations were primarily attributed to the significant drop in oil prices during these years, which subsequently impacted the total public revenues, and thus affected the fiscal space in Algeria.

Despite the previous fluctuations, there was a slight expansion in the fiscal space observed in 1999, leading to a positive value of about 11.43% in 2000. Subsequently, Algeria entered a prolonged period characterized by a wide fiscal space from 2000 to 2008. The peak of the fiscal space was reached in 2006, recording about 13.52%. These favorable financial conditions are likely attributed to strong economic factors, primarily influenced by the high oil prices during this timeframe and the reforms implemented by Algeria, including the monetary and loan law.

On the contrary, the global economic crisis in 2008, along with the oil price shock in mid-2014, posed significant challenges to fiscal space in Algeria. These external shocks had a profound

impact on the country's financial landscape, leading to shifts in fiscal dynamics. In 2015, the budget recorded a record deficit, reaching 52,553.2 billion dinars, equivalent to 15.4% of the Gross Domestic Product (GDP), compared to 7.3% in 2014 and 0.4% in 2013. This substantial deficit was the result of an increase in public expenditure (+660.6 billion dinars) and a decrease in budget revenues (635.3 billion dinars), resulting in a decline in the flow of public savings (total revenues minus operating expenses) to 486.1 billion dinars, compared to 1,244.1 billion dinars in 2014. Consequently, only 9.5% of total revenues were covered in 2015, a significant decrease from 21.7% in 2014.

The continued large deficit in the balance of payments since 2014 had a profound impact on Algeria's official foreign reserves. It is worth noting that these reserves experienced a significant contraction, declining from 182.22 billion US dollars at the end of December 2011 to 114.13 billion US dollars at the end of 2016. This trend persisted, and by the end of December 2021, official foreign reserves had further decreased to 45.30 billion US dollars, indicating a significant erosion of reserves by more than 75% over a decade, equivalent to an average annual decrease of approximately 14 billion US dollars. (For more information, refer to the Bank of Algeria report (Bank of Algeria, 2022). It is worth mentioning that the Algerian government's budget faced significant financial challenges resulting from a combination of factors, including the oil price shock and the impact of the COVID-19 pandemic. These conditions forced Algeria to exceed its actual initial balance (Observed primary balance), indicating the economic pressures the country is facing.

IV- Methods and Materials:

This study focuses on the Algerian economy over the period from 1990 to 2022, targeting the relationship between public debt and the primary budget balance as a means to assess fiscal space. Given the limited number of annual observations (33 years), the data were converted from annual to quarterly frequency using the cubic spline interpolation technique, resulting in 132 observations from 1990 Q1 to 2022 Q4. This interpolation method, previously applied by Akar (2019) and Chibi et al. (2022), allows for improved model estimation by increasing the number of data points without altering the underlying trends

Table1: Data Source

independent variables		
Variables	Sources	Descriptions
Oil _PRICE	Oil prices and data were collected from the OPEC Basket Price website	Oil prices
OIL_REVENUE	Petroleum collection revenues. Data were collected from the National Office of Statistics (ONS) and bulletins of the Bank of Algeria	Petroleum revenues
RG_CYCL	Data on spending were collected from the International Monetary Fund and then divided by inflation to obtain the real government spending variable. Then calculate it using the HP filter. $RG\_CYCL_t = \frac{g_t - g_t^T}{y_t}$	Government spending gap
RGDP_CYCL	Data were collected from the World Bank. It was calculated using the HP filter. $RGDP\_CYCL_t = \frac{y_t - y_t^T}{y_t}$	Output gap
INF	Data were collected from the World Bank website	Inflation rate

TAX_ PRESS	The data was collected from the publications of the Bank of Algeria and the National Office of Statistics, and the calculation method is explained as follows: Tax pressure on non-hydrocarbons = (tax revenues on non-hydrocarbons / GDP on non-hydrocarbons) x 100	Tax pressure rate (outside the fuel sector)
DEBT	.Data were collected from the International Monetary Fund (FMI)	Total government debt
Population	Data were collected from the World Bank website	Population density rate
		dependent variable
PB	data were collected from the International Monetary Fund.	Primary budget balance

IV-2 Methodology

In this study, we will adopt the methodology of Ostry et al. (2010) and Gosh et al. (2013) to investigate the phenomenon of fiscal fatigue in Algeria using the ARDL model for the period from 1990 to 2022. However, due to the small sample size of the study, we used the method of extending the sample from annual data to quarterly data for the same period using the cubic spline interpolation method to extend the studied series from the first quarter of 1990 to the fourth quarter of 2022 (1990 Q1-2022 Q4). As an alternative to using annual data with only one lag, we chose to work with quarterly data with a lag of four. Conducting a study of the fiscal policy reaction function using annual data is logical because budgets are usually approved on an annual basis, and government responses to economic changes often occur in the following year. However, it is important to recognize that annual data may limit the number of observations, given the study period extending from 1990 to 2022. By converting annual data to quarterly data, the time series can be effectively lengthened, which can be valuable for conducting long-term trend analysis and historical comparisons. Additionally, quarterly data is more suitable for identifying specific fiscal policy regimes, as indicated by Chibi et al. in their 2022 study. It is worth noting that this method has been used in several previous studies, including the study by (AKAR, 2019) and (Chibi, et al., 2022).

The starting point in estimating our model is the simplest case of the Fiscal Reaction Function (FRF) proposed by (Bohn, 1998):

$$pb_t = \beta_0 + \beta_1 deb_{t-1} + \varepsilon_t \text{.....3}$$

According to Bohn's (1998) seminal contribution, primary balance should increase following an increase in the ratio of public debt to GDP in order to ensure the sustainability of government budgets and meet intertemporal budget constraints. Bohn (2008) further clarified that for an economy to meet intertemporal budget constraints and achieve a No-Ponzi condition, a coefficient **β1> 0** is sufficient as it improves the primary balance (fiscal surplus) with increasing debt. (Bohn, 2008, pp. 1-46)

• In which deb_{t-1} in the equation represents the debt lagged by one period, and coefficient **β1** is expected to be positive and very small for the case of Algeria. By adding a set of fixed variables Z to equation (1) to monitor cyclical effects, we developed equation (4):

$$pb_t = \beta_0 + \beta_1 deb_{t-1} + \sum_i \emptyset_i Z_i + \varepsilon_t \text{.....4}$$

Where the additional variables represent the periodic components (output gap and real government spending gap), in addition to aggregate economic variables added to align with the nature of the Algerian economy.

In contrast, (Mendoza & Ostry, 2008) found that the response of the primary balance to debt weakens at high debt levels. Therefore, in such cases, Bohn's condition is considered a "weak sustainability" state, as indicated by (Ghosh, et al., 2013, pp. 1-33). It turns out that a positive value alone may not be sufficient to achieve financial sustainability, especially when there are limits to the positive values of the primary balance (e.g., at very high debt levels) or when considering market reactions. Consequently, Ghosh et al. (2013) made a significant contribution to the literature by proposing nonlinear specifications for the FRF, representing financial fatigue in the context of cubic multi-threshold specifications. Financial fatigue can be described as "having medium rebound properties in the primary balance at high levels of public debt" (Checherita-Westphal & Žďárek, 2017).

The core cubic specifications of the nonlinear FRF are as follows:

$$pb_t = \beta_0 + \beta_1 deb_{t-1} + \beta_2 debt^2_{t-1} + \beta_3 debt^3_{t-1} + \varepsilon_t \text{.....(5)}$$

The motivation behind the quadratic and cubic specifications is the idea that the primary surplus may interact more significantly with lagged public debt at some debt levels and become less responsive at higher debt levels, a phenomenon known as "financial fatigue." Twisted specifications are also used to capture potential financial fatigue by following Ghosh et al. (2011), where debt boundaries are defined by the maximum level of public debt that the primary balance cannot adjust to achieve debt stability.

The financial fatigue condition is met if **β3 <0** in equation (3). In this case, the declining response of the primary balance to increasing debt is incurred. To clarify further: In this scenario, the concept of the declining response of the primary balance implies that the effect of debt increase on the economic system shows a continuous and irreversible pattern. The term "decline" indicates that the effects of past events, such as debt accumulation, continue to influence the system even after the initial shock subsides. With rising debt levels, a self-reinforcing loop may emerge, leading to a sustainable deviation from the system's original balance. This may have a long-term negative impact on economic stability, requiring careful study by policymakers to understand and address the underlying dynamics to restore a more suitable balance. In this context, it is worth noting that the FRF has been expanded in equation (3) to align with the specificity of the Algerian economy by adding additional variables to the model:

$$pb_t = \beta_0 + \beta_1 deb_{t-1} + \beta_2 debt^2_{t-1} + \beta_3 debt^3_{t-1} + \sum_i \alpha_i Z_i + \varepsilon_t \text{.....6}$$

V- Results and discussion :

V-1 Unit root tests:

We conduct unit root tests to ensure that none of the variables carry second-order characteristics (I (2)), as the results of the F-test can be misleading if there are variables with integrated order I (2). Therefore, we examined the time series for stationarity using unit root tests, especially the Augmented Dickey-Fuller test, and the results are as follows:

Table 2: Augmented Dickey-Fuller Unit Root Test

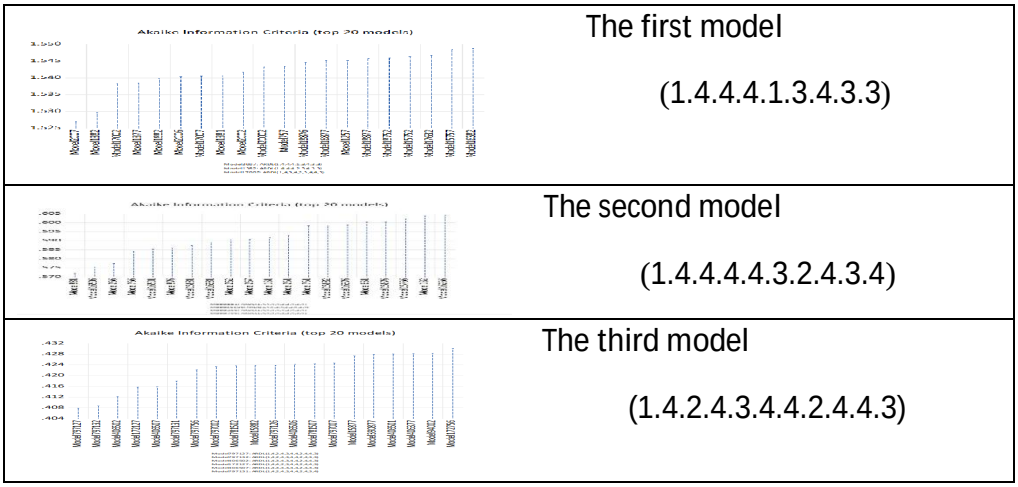
variables	Level			First difference			The result
	(Ttab) at 5%	t-ADF	(Prob)	(Ttab) at 5%	t-ADF	(Prob)	
Pb	3.449020-	1.554241-	0.8048	2.886509-	2.900799-	0.0483	I (1)
DEBT	1.943612-	0.407681-	0.5347	1.943612-	1.957651-	0.0484	I (1)
OIL_PRICE	1.943612-	0.537110	0.8306	1.943612-	2.516423-	0.0121	I (1)
TAX_PRESURE	3.449020-	3.136890-	0.1028	3.449365-	4.792719-	0.0008	I (1)
INF	3.449020-	3.010666-	0.1339	3.449365-	4.275599-	0.0048	I (1)
RG_CYCL	-1.943612	-2.720331	0.0068	-	-	-	I (0)
RGDP_CYCL	-3.449020	-3.052412	0.1229	-3.449020	-3.645317	0.0303	I (1)
OIL_REVENUE	1.943612-	0.577598-	0.4651	1.943612-	2.709605-	0.0070	I (1)

Source: Author's development.

The results shown in Tables (2) indicate that most of the series under study did not stabilize at the level, requiring moving to the first difference where they stabilized with an increase in the calculated Dickey-Fuller statistic values at the tabulated values at a 5% significance level. Therefore, it appears that all of them are integrated of the same degree I (1), except for the time series related to the cyclical components of real expenditure, which is noted to have stabilized at level I (0).

V-2 Analyzing the Lag Structure

Figure 2: Results of Lag Structure



Source: Author's development.

V-3 Cointegration Test Using the Bounds Test (Fisher):

To assess the existence of a long-term equilibrium relationship, often referred to as cointegration, between the primary budget balance and other explanatory variables, we used the bounds test.

This test helps determine the upper and lower bounds of the F-statistics (bounds test) by comparing the null hypothesis (no cointegration between variables) with the alternative hypothesis (existence of cointegration between variables). If the calculated F-statistics exceed the critical

values at different significance levels, we reject the null hypothesis and accept the alternative hypothesis, indicating the presence of a cointegration relationship. Conversely, if the F-statistic is less than the critical values, we find no evidence of cointegration. (Pesaran, et al., 2001).

Table 3: Cointegration Test Using the Bounds Approach Test

	F-statistic	*I (0)*			*I (1)*		
		%2.5	%5	%10	%2.5	%5	%10
The first model	4.171947	2.33	2.11	1.85	3.42	3.15	2.85
The second model	4.530727	2.24	2.04	1.8	3.35	2.08	2.8
The third model	5.100442	2.18	1.98	1.76	3.28	3.04	2.77

Source: Author's development.

The table above shows that the calculated values for the F-Bounds Test statistic in the three studied models are respectively 4.17, 4.45, 5.10. By comparing these with the critical values at various significance levels, we observe that they exceed all the critical values, and therefore, we accept the alternative hypothesis and reject the null hypothesis. This confirms the existence of a long-term equilibrium **relationship** between the primary budget balance and the other explanatory variables in the long term. Accordingly, the long-term relationship provides evidence of meeting the necessary condition for achieving debt sustainability in the long term. However, Bohn (1998) believes that cointegration between the surplus and debt does not guarantee that the debt will not explode in the long term. Therefore, he argues for the presence of a positive and significant coefficient for the debt as a sufficient condition for debt sustainability while Mendoza & Ostry (2008) and Ghosh et al. (2013) believe that positive values alone may not be sufficient to achieve financial sustainability.

V-4 Diagnostic Tests:

These diagnostic tests are conducted to assess and measure the quality of the model, as follows:

Table 4: Results of the Diagnostic Tests

	Diagnostic Tests								
	Breusch-Pagan-Godfrey			**Breusch-Godfrey Serial Correlation LM Test**			**Ramsey RESET Test**		
	F-statistic	**Prob. F**	**Prob. Chi-Square**	**F-statistic**	**Prob. F**	**Prob. Chi Square**	**t-statistic**	**F-statistic**	**Probability**
model 01	1.006328	0.4613	0.4415	3.392808	0. 3730	0.2050	1.412944	1.996411	0.1606
model 02	0.773573	0.7391	0.7060	6.153919	0.3087	0.1020	1.7662	3.119730	0.0802
model 03	1.068417	0.3918	0.3792	0.692896	**0.5032**	**0.3312**	1.096865	1.203113	0.2752

Source: Author's development.

V-5 Estimating the Long-Term Relationship:

Table 5: Estimation of Long-Term Coefficients.

variables	DEBT	SQUER_DEBT	CUBIC_DEBT	RG_CYCL	RGDP_CYCL	OIL_PRICE	OIL_REVENUE	POPULATION	INF	TAX_PRESURE	C
model 01	0.119782 (0.0006)	-	-	0.139527 (0.0323)	0.278475 (0.2902)	0.159923 (0.0000)	0.680334 (0.0000)	-13.86348 (0.0001)	0.272985 (0.0187)	0.331189 (0.5359)	-8.800067 (0.4599)
model 02	-0.061003 (0.3504)	0.001235 (0.0143)	-	0.009973 (0.8150)	0.122985 (0.6031)	0.058088 (0.0652)	0.674748 (0.0000)	-10.12619 (0.0029)	0.138021 (0.1905)	0.682641 (0.1884)	-10.19918 (0.4120)
model 03	-0.671040 (0.0001)	0.013968 (0.0001)	-7.06E-05 (0.0002)	0.011110 (0.7968)	-0.721305 (0.8324)	0.075480 (0.0175)	0.693979 (0.0000)	-17.94592 (0.0001)	0.267168 (0.0270)	0.880541 (0.1032)	4.150706 (0.7470)

Source: Author's development.

As shown in Table 5, the long-run estimation results highlight distinct fiscal responses across the three models. In Model 1, the coefficient on lagged debt is positive and statistically significant ($\beta_1 = 0.1198$; $p < 0.01$), indicating that as debt increases, the primary balance improves—suggesting fiscal responsiveness consistent with Bohn's (1998) sustainability condition.

In contrast, Model 2 shows a marginally positive but economically weak quadratic coefficient ($\beta_2 = 0.0012$; $p < 0.05$), implying limited fiscal capacity at rising debt levels. More notably, Model 3 reveals a negative and significant cubic term ($\beta_3 = -7.06E{-}05$; $p < 0.01$), confirming the presence of fiscal fatigue. This result indicates that at high debt levels, the fiscal authority's ability to generate surplus diminishes, increasing the risk of unsustainable debt dynamics—consistent with the findings of Ghosh et al. (2013).

Moreover, inflation shows a positive effect on the primary balance, likely due to oil-linked revenue gains. Oil price and oil revenue variables also exhibit significant positive coefficients, reflecting Algeria's strong dependence on hydrocarbons. Conversely, population growth negatively affects the fiscal balance due to increased expenditure needs. Meanwhile, the output gap (RGDP_CYCL) and non-hydrocarbon tax pressure.

V-6 Estimation of the Error Correction Model (ECM):

After estimating the long-term relationship between the primary budget balance and the independent variables, we will proceed to estimate the Error Correction Model, which captures the short-term dynamics between the explanatory variables and the dependent variable. The short-run estimation equations for the three models are as follows:

- **The first model**

$$\Delta pb_t = \beta_0 + \sum_{i=1}^{p} \alpha_i \Delta pb_{t-i} + \sum_{i=1}^{m} \beta_1 \Delta\ debt_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta\ inf_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta\ oil_{price_{t-i}} + \sum_{i=1}^{n} \alpha_4 \Delta\ oil_{revenue\ t-i} + \sum_{i=1}^{n} \alpha_5 \Delta\ population_{t-i} + \sum_{i=1}^{n} \alpha_6 \Delta\ tax_{pressure\ t-i} + \sum_{i=1}^{n} \alpha_7 \Delta\ rg_{cycl\ t-i} + \sum_{i=1}^{n} \alpha_8 \Delta\ rgdp_{cycl_{t-i}} + \gamma ECT_{t-1} + \mu_t$$

Published on 30-12-2025 in the el-Bahith review (Mağallaẗ al-bāḥiṯ) : https://elbahithreview.edu.dz

- **The second model**

$$\Delta pb_t = \beta_0 + \sum_{i=1}^{p} \alpha_i \Delta pb_{t-i} + \sum_{i=1}^{m} \beta_1 \Delta\, debt_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta\, debt^2_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta\, inf_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta\, oil_{price_{t-i}} + \sum_{i=1}^{n} \alpha_4 \Delta oil_{revenue\, t-i} + \sum_{i=1}^{n} \alpha_5 \Delta\, population_{t-i} + \sum_{i=1}^{n} \alpha_6 \Delta\, tax_{pressure\, t-i} + \sum_{i=1}^{n} \alpha_7 \Delta\, rg_{cyct\, t-i} + \sum_{i=1}^{n} \alpha_8 \Delta\, rgdp_{cyct_{t-i}} + \gamma ECT_{t-1} + \mu_t$$

- **The third model**

$$\Delta pb_t = \beta_0 + \sum_{i=1}^{p} \alpha_i \Delta pb_{t-i} + \sum_{i=1}^{m} \beta_1 \Delta\, debt_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta\, debt^2_{t-i} + \sum_{i=1}^{m} \beta_3 \Delta\, debt^3_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta\, inf_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta\, oil_{price_{t-i}} + \sum_{i=1}^{n} \alpha_4 \Delta oil_{revenue\, t-i} + \sum_{i=1}^{n} \alpha_5 \Delta\, population_{t-i} + \sum_{i=1}^{n} \alpha_6 \Delta\, tax_{pressure\, t-i} + \sum_{i=1}^{n} \alpha_7 \Delta\, rg_{cyct\, t-i} + \sum_{i=1}^{n} \alpha_8 \Delta\, rgdp_{cyct_{t-i}} + \gamma ECT_{t-1} + \mu_t$$

Table 6: ECM Regression

variables	*model01*	*model 02*	*model 03*
D(DEBT)	0.012559	-0.053937	-
	(0.7043)	(0.1498)	
D (DEBT (-1))	-0.101356	-0.085876	-
	(0.0029)	(0.0058)	
D (DEBT (-2))	-0.101356	-0.085876	
	(0.0029)	(0.0058)	
D (DEBT (-3))	-0.101356	-0.085876	-
	(0.0029)	(0.0058)	
D(RG_CYCL)	-0.015643	-0.032725	-0.034472
	(0.4250)	(0.0894)	(0.0640)
D (RG_CYCL (-1))	-0.054841	-	-
	(0.0035)		
D (RG_CYCL (-2))	-0.054841	-	-
	(0.0035)		
D (RG_CYCL (-3))	-0.054841	-	-
	(0.0035)		
D(RGDP_CYCL)	-	-	-0.008396
			(0.9567)
D (RGDP_CYCL (-1))	-	-	-0.465400
			(0.0039)
D (RGDP_CYCL (-2))	-	-	-0.465400
			(0.0039)
D (RGDP_CYCL (-3))	-	-	-0.465400
			(0.0039)
D(POPULATION)	-10.96234	-	-13.98999
	(0.0020)		(0.0001)
D(OIL_PRICE)	0.202734	0.195726	0.206355
	(0.0000)	(0.0000)	(0.0000)
D (OIL_PRICE (-1))		0.064613	0.069632
	-	(0.0013)	(0.0006)
D (OIL_PRICE (-2))		0.064613	0.069632
	-	(0.0013)	(0.0006)
D (OIL_PRICE (-3))		0.064613	0.069632
	-	(0.0013)	(0.0006)
D(OIL_REVENUE)	0.419316	0.458056	0.420242
	(0.0000)	(0.0000)	(0.0000)
CointEq(-1)*	-0.395599	-0.437825	-0.428389
	(0.0000)	(0.0000)	(0.0000)
R	0.702861	0.707632	0.721472

Source: Author's development.

Model Estimation in the Short Term with the Error Correction Model (ECM): After establishing the long-term relationship between the core budget balance and the explanatory variables, the error correction model is estimated, and the results are shown in Table (6).

Statistical and Economic Analysis of the Results: The table shows that the error correction coefficient **cointEq_ (-1)** has a negative value, as required and expected, and is statistically significant at a 5% significance level. This indicates that 42.83% of short-term errors can be corrected in the long term within the time units (number of lag periods) of the three models according to the Akaike criterion, confirming the negative sign that indicates the speed of adjustment from the short to the long term. Regarding the statistical assessment of the model, we notice that the values of the determination coefficient R^2 are 70.28%, 70.76%, and 72%. This means that the model is statistically acceptable and logical.

The variable "RGDPCYCL" represents the output gap, and the short-term analysis confirms that "RGDPCYCL" is negative and significant, and its impact increases with the accumulation of years. An increase of this variable by one unit will lead to a 46.54% reduction in the initial budget balance, confirming the government's procyclical reaction to economic cycles as fiscal policy in Algeria is largely affected by oil price fluctuations. This result lends credibility to the findings of Abiad and Ostry (2005) and (Asiama, et al., 2014, pp. 1-33), which suggest that developing economies tend to exhibit procyclical behavior in response to production fluctuations compared to the countercyclical behavior exhibited by advanced economies. (For further reading, see the study by (Abiad & Ostry, 2005).

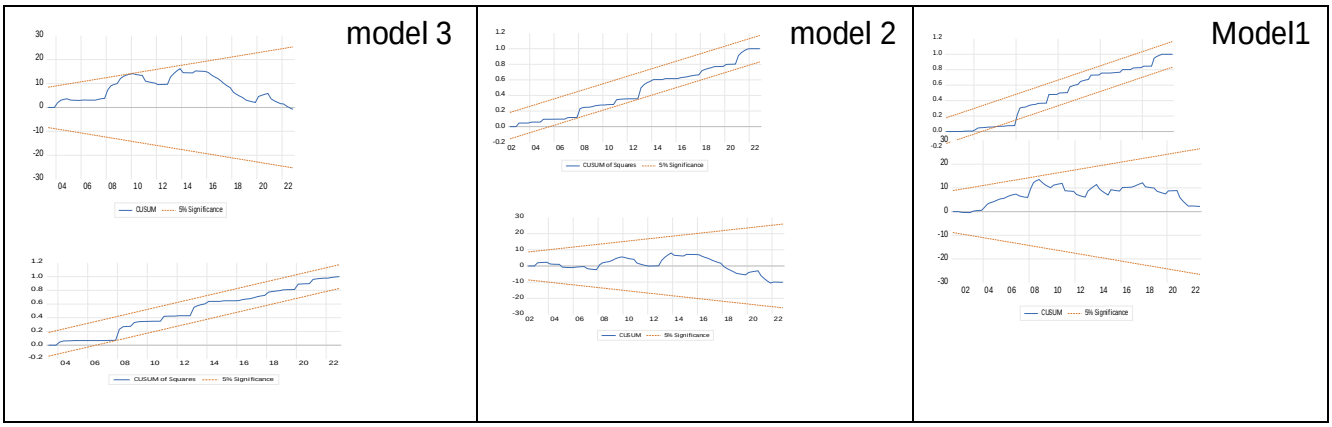
Meanwhile, the coefficients of the expenditure gap RG_CYCL show the procyclical nature of fiscal policy (its values are negative and significant), where an increase of this variable by one

unit will lead to a 5.48% decrease in the budget balance. Thus, it can be said that there is no countercyclical reaction to cyclical fluctuations and no ultimate correction of the budget deficit in line with changes in the debt level. These results are easily in line with the predictions of Bohn (1998) based on (Barro, 1979) Tax-Smoothing Theory, which states that temporary government expenditures (as a result of shock needs for spending) lead to an increase in the primary deficit, meaning always a decrease in the primary surplus. Therefore, shocks to spending needs can lead to an untenable government debt position. These results also align with the findings of Chibi et al. (2022) regarding Algeria.

V-7 Stability of the model:

The structural staticity of the ARDL model must be tested to confirm the validity and accuracy of its results, by testing the cumulative sum of the residuals as well as testing the cumulative sum of the squares of the residuals. If the curve for both tests is within the range of critical limits at the 5% level, the null hypothesis will be accepted, which assumes that the variables Static. The "CUSUM" and "CUSUM of Squares" tests are used to discover the structural stability of the estimated parameters, within the short- and long-run relationship, and it is shown in the following graph:

Figure 03: Results of Cusum and Cusum square.



Source: Author's development.

V-8 Measuring Fiscal space

We attempted to determine the empirical validity of the cubic shape for the financial response function, which allows for calculating debt limits as suggested by Ostry et al. (2010). To derive debt limits, the estimated coefficients from Equation (1) (where the term is assumed to be a cubic function) are entered into this equation:

$$(r_t - g_t)\overline{d_t} = \beta_0 + \beta_1 d_t + \varepsilon_t \Rightarrow \bar{d}_t = \frac{\beta_0 + \beta_1 d_t + \varepsilon_t}{(r_t - g_t)}$$

Therefore, to conduct our calculations related to fiscal space, we also need to calculate the difference between the real interest rate growth(r−g). We consider the historical average of the implicit nominal interest rate on government debt (interest payments divided by end-of-period debt) compared to the nominal Gross Domestic Product (GDP) growth rate (in the Algerian case, equals 1.18 percent). The results indicate that the debt-to-GDP ratio is 62.9% based on the historical average of (r−g, and thus, the fiscal space is estimated at 0.10, which **is a very weak value and cannot be relied upon for budget maneuvering.** Therefore, it can be said that Algeria does not possess a fiscal space that allows it to expand spending or withstand shocks.

VI- Conclusion:

This study investigated the dynamics of fiscal space in Algeria over the period 1990–2022 by estimating three versions of the fiscal reaction function using the ARDL methodology, with particular attention to the phenomenon of fiscal fatigue. To address data limitations, annual observations were converted to quarterly data using the cubic spline interpolation technique, allowing for more robust time-series estimation. The findings demonstrate that while Algeria exhibits a positive fiscal response to debt in the linear model ($\beta_1 > 0$), the cubic model reveals a negative and statistically significant coefficient ($\beta_3 = -7.06E{-}05$), confirming the presence of fiscal fatigue. This suggests that at high debt levels, the government's capacity to adjust its fiscal stance diminishes, posing risks to long-term sustainability.

Oil prices and oil revenues were found to significantly improve the primary budget balance, reinforcing Algeria's dependency on hydrocarbons. However, this reliance limits fiscal resilience and exposes the economy to external shocks. Population growth contributes to fiscal pressure, while the effects of government spending gaps diminish in the presence of debt. Moreover, the output gap (RGDP_CYCL) and non-oil tax pressure (TAX_PRESS) showed no significant impact, reflecting structural constraints in Algeria's fiscal framework.

Given these circumstances, it becomes increasingly necessary to explore and implement strategic measures to overcome these challenges and capitalize on potential opportunities for achieving sustainable economic growth and resilience. This study aims to provide a series of recommendations designed to address these urgent economic concerns in Algeria, including: the necessity of coordination between fiscal and monetary policies, as uncoordinated policies can lead to interest rate fluctuations and undermine fiscal stimulus efforts; enhancing investments in sectors such as manufacturing, services, and agriculture to create alternative revenue sources and reduce vulnerability to oil price fluctuations; implementing flexible mechanisms for the continuous monitoring and evaluation of key economic indicators to ensure policy effectiveness and adaptability; establishing sovereign wealth funds or stabilization funds to save a portion of oil revenues and create a financial cushion against oil price volatility; enhancing financial inclusion through digital payment systems to improve transparency and reduce tax evasion; establishing a specialized financial council of diverse economic experts to monitor financial reactions and provide advice; addressing the informal sector to broaden the tax base and improve revenue collection; and implementing fair tax reforms to ensure equitable distribution of the tax burden. Through these strategies, Algeria can enhance economic stability, reduce reliance on volatile oil revenues, and move towards more sustainable and balanced financial prospects.

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