

Analyzing public expenditure growth in Algeria using the Wavelet analysis: An empirical study for the period 1962-2023

تحليل نمو الإنفاق العمومي في الجزائر باستخدام تحليل الموجات: دراسة تجريبية للفترة 1962-2023

Daoudi Mohammed *

University centre of Maghnia (Algeria), Email, m.daoudi@cu-maghnia.dz

Received: 22/03/2025;

Accepted : 27/06/2025;

Published: 30/06/2025;

Abstract:

This study analyzes the growth of public expenditure in Algeria over the period from 1962 to 2023 using wavelet analysis to identify fluctuations across different time horizons. The results showed that fluctuations are high in the short term due to economic shocks, while expenditure becomes more stable in the long run. The study also confirmed the role of wavelet analysis in understanding the nature of economic changes and the importance of adopting flexible fiscal policies to address shocks. The research concluded that diversifying revenue sources and reducing dependence on oil are essential for achieving sustainable financial stability.

Keywords: Public expenditure; wavelet analysis; financial fluctuations; economic shocks; fiscal policy.

Jel Classification Codes : C14; E62; H50; O53

*Corresponding author,

Introduction:

Public expenditure is one of the main tools used by governments to achieve their economic and social objectives, playing a crucial role in fostering economic growth, ensuring financial stability, and promoting sustainable development. In Algeria, public spending is heavily dependent on oil revenues, making it vulnerable to fluctuations caused by external and internal economic shocks, such as oil price volatility, global financial crises, and economic policies. These fluctuations may impact the sustainability of public finances, particularly given the increasing economic challenges facing the country, including budget deficits, rising public debt, and weak economic diversification.

In this context, financial fluctuation analysis has become an essential tool for understanding the dynamics of public expenditure, as it helps explain the nature of financial variations over time, enabling governments to develop more flexible and effective economic policies. Among the modern techniques used for financial fluctuation analysis is Wavelet Analysis, which is distinguished by its ability to detect cyclical patterns in data across different time periods. This makes it a suitable tool for examining short-, medium-, and long-term variations in public expenditure.

Based on the above, this study aims to address the following research question: To what extent do economic shocks affect public expenditure fluctuations in Algeria, and what are the key factors that explain these fluctuations in the short, medium, and long term? The study seeks to analyze the behavior of public expenditure in Algeria over different time periods, identify the economic factors influencing government spending fluctuations, apply wavelet analysis methodology to detect financial imbalances and economic shocks, and provide recommendations for policymakers on how to enhance public expenditure stability and avoid financial crises.

To address the research question, the study employs wavelet analysis through various tools, including Wavelet Variance Analysis to determine the level of fluctuations in public spending across different time periods, Outlier Detection to identify unusual changes that may be linked to major economic events such as financial crises or policy adjustments, and Wavelet Shrinkage Estimator to filter out noise from the data and analyze the true trends in government spending.

Based on previous studies and available data, this study hypothesizes that public expenditure in Algeria exhibits high volatility in the short term, influenced by factors such as fluctuations in oil prices and short-term fiscal policies that rely on expansionary spending during periods of high oil revenues. In the long term, public expenditure appears to be more stable due to successive governments' efforts to control budget deficits through austerity measures or economic reform plans. Major economic crises lead to significant increases in public expenditure variance, as the government resorts to sharp increases in public spending as an exceptional measure to address social and economic crises. Additionally, wavelet analysis helps identify critical time periods that witnessed significant changes in government spending, improving the ability to predict future financial crises and propose more sustainable policies.

From a theoretical perspective, this study contributes to the economic literature on financial analysis of public expenditure by providing a dynamic perspective based on wavelet analysis rather than traditional methods that assume stability over time. On a practical level, it offers precise analytical tools that can be used by policymakers, economic researchers, and financial planners to understand the impact of economic shocks on public expenditure, thereby assisting in the design of more flexible and sustainable fiscal policies.

Based on the analysis presented in this study, the findings can contribute to steering Algerian fiscal policy toward greater stability and efficiency by adopting strategies based on in-depth data analysis rather than unsustainable reactive measures. Furthermore, the research outcomes can serve as a valuable reference for further studies on the relationship between economic fluctuations and public expenditure in resource-dependent economies.

I-Theoretical framework:

Public spending is one of the most important tools of fiscal policy that governments rely on to achieve economic development and social stability. Most countries, especially developing ones, have experienced a continuous increase in the volume of public spending, which has attracted the interest of researchers in studying its causes and effects. Public spending includes various expenditures incurred by the state to provide public services and achieve its economic and social objectives. It can be classified into current spending, which covers salaries, wages, and operational expenses; investment spending, directed towards infrastructure and development projects; and social spending, which includes subsidies and government support for essential goods.

Wagner's Law is recognized as the earliest model of public expenditure in the history of public finance. It proposes that as an economy develops, the proportion of public spending relative to national income tends to increase (Wagner, 1883). However, (Peacock & Scott, 2000) authored a paper titled "The Curious Attraction of Wagner's Law," in which they explored the reasons why this seemingly outdated theory continues to capture the interest of modern economists. In contrast, Keynes (1936) viewed public spending as an exogenous variable that could be employed as a policy tool to stimulate economic growth. Additionally, Peacock and Wiseman (1961) introduced the displacement effect, suggesting that during periods of war, tax rates...are increased to generate more revenues, sustaining the increase in defense spending. While Peacock and Wiseman (1979) surveys the literature on public expenditure growth. (Rowley & Tollison, 1994). The Welfare State Theory argues that modern governments are responsible for providing extensive social services, leading to a continuous increase in public spending to meet the growing needs of society. (Albrekt, 2007)

The rise in public spending is attributed to several interrelated factors. Economically, an increase in GDP raises state revenues, enabling greater spending, while inflation drives up the cost of government-provided services, necessitating higher expenditures to keep up with rising prices. Similarly, rising public debt levels lead to increased debt servicing costs, further inflating government spending. Additionally, social factors play a key role, as population growth increases demand for essential services such as healthcare and education, while higher living standards reinforce public expectations for greater government support and improved service quality. (Benard, 2016)

Political and administrative factors also influence spending levels, with socialist or expansionary governments tending to increase expenditures to fulfill their social programs. At the same time, administrative corruption and mismanagement of public funds can contribute to inflated expenses without yielding real developmental benefits. External factors cannot be overlooked either, as global financial crises often push governments to increase spending to counteract economic downturns, and fluctuations in oil prices directly impact the spending capacity of resource-dependent nations. (Muzellec, 1995)

The effects of rising public spending are mixed. On one hand, it can stimulate economic growth, enhance public services, and reduce unemployment. On the other hand, excessive spending

can lead to budget deficits, rising inflation, and increased public debt, threatening the state's financial stability. Therefore, controlling the pace of public spending through sound fiscal policies is essential to ensuring sustainable development without causing financial imbalances that could negatively affect the economy. (Llau, 1996)

Recent findings on the impact of government spending shocks on consumption are difficult to reconcile with existing optimizing business cycle models. To address this, we extend the standard New Keynesian framework by incorporating rule-of-thumb (non-Ricardian) consumers. Our analysis demonstrates that the interaction between these consumers, sticky prices, and deficit financing can effectively explain the observed effects of government spending. (Galí, López-Salido, & Vallés, 2004)

Despite its low public spending, Switzerland achieves strong outcomes in health, education, and transportation. However, with an aging and growing population, improving spending efficiency is crucial to maintaining low taxes. Enhancing early childhood education, particularly for disadvantaged children, and aligning tertiary education with labor market needs can boost long-term economic performance. Healthcare efficiency could be improved through managed-care networks and better data collection, while peak-load pricing could ease transportation congestion. Additionally, addressing rising social security entitlements by linking retirement age to life expectancy and reforming fiscal equalization to strengthen tax incentives would help allocate public funds more efficiently. (Dutu, 2016)

The study of Klein and Linnemann employs structural proxy-vector autoregressions to distinguish between shocks from U.S. government investment and consumption expenditures. Findings reveal that public investment shocks raise inflation but have little effect on labor productivity, while public consumption shocks lower inflation and significantly boost productivity. The results align with a model where demand shocks influence productivity through variable technology utilization, explaining why investment is inflationary in the short run, whereas consumption can temporarily enhance productivity and reduce inflation. (Klein & Linnemann, 2023)

Researchers have utilized various wavelet techniques to study financial dynamics. Pinho et al. applied DWT, MODWT, and cross-wavelet power to analyze stock indices, while Shik Lee used DWT and MRA to explore interactions between the KOSPI and DJIA indices. MODWT has also been employed to investigate stock returns and economic growth, analyzing DJIA and U.S. industrial production data. (Pinho & Madaleno, 2009)

Rua and Nunes studied co-movements among major economies using wavelet squared coherency (Rua & Nunes, 2009), while Tiwari et al. applied CWT to examine stock market contagion in PIIGS countries, analyzing volatility and crisis-driven fluctuations. Wavelet coherence and phase difference analysis were used to determine market lead-lag relationships. (Tiwari, Mutascu, & Albulescu, 2016)

Using cross-wavelet analysis, the study by Aguiar-Conraria and Soares examines the time-frequency effects of oil price changes on the macroeconomy. The relationship between oil prices and industrial production varies across different periods and frequencies, leading to instability in empirical findings. Additionally, the volatility of inflation and industrial output began to decline in the 1950s and 1960s. (Aguiar-Conraria & Soares, 2011)

Similarly, the study by Benhmad employs a wavelet approach to analyze the linear and nonlinear Granger causality between the real oil price and the real effective U.S. dollar exchange rate. Instead of examining the time series at their original level, the study decomposes the variables at different resolution scales to investigate their relationships across time horizons. The findings indicate that causality varies across frequency bands and time scales. Over long horizons, there is a strong bidirectional causal relationship between oil prices and the exchange rate, particularly among institutional investors and fund managers. However, in the short term (approximately three months), which is associated with speculative traders, causality runs only from oil prices to the real exchange rate. (Benhmad, 2012)

II-The wavelet approaches:

II-1- The Maximal Overlap Discrete Wavelet Transform (MODWT):

The Maximal Overlap Discrete Wavelet Transform (MODWT), also known as the Stationary Wavelet Transform (SWT), extends the Discrete Wavelet Transform (DWT) using the "à trous" algorithm. Unlike DWT, MODWT is shift-invariant, maintaining consistency under circular shifts in time series analysis. By up-sampling filters at each level, MODWT retains the same number of samples in each coefficient set, making it a redundant yet flexible tool. Its ability to capture complex patterns and detect anomalies makes it highly effective for time series analysis. (Percival & Walden, 2006)

The Maxima Overlap Discrete Wavelet Transform (MODWT) is a technique used to decompose a signal into multilevel wavelet and scaling coefficients. The MODWT offers several advantages over the conventional discrete wavelet transform (DWT). For instance, the MODWT can process data of any sample size and is translation-invariant, meaning that a shift in the original time series results in a corresponding shift in the transform coefficients. These properties make the MODWT particularly suitable for time series analysis. (Quilty&Adamowski, 2018)

wavelet and scaling coefficients W_j and V_j are defined as:

$$W_{j,t} = \sum_{l=0}^{n-1} \widetilde{h}_{j,l} p_{t-1} \bmod N$$

$$j = 1, 2, \dots, l$$

$$V_{j,t} = \sum_{l=0}^{n-1} \widetilde{g}_{j,l} p_{t-1} \bmod N$$

$$p = \{p_t, t = 0, 1, \dots, N - 1\}$$

Where $\widetilde{h}_{j,l}$ is the MODWT wavelet filters ($\widetilde{h}_{j,l} = \frac{h_j}{2^{j/2}}$); $\widetilde{g}_{j,l}$ the scaling filters ($\widetilde{g}_{j,l} = \frac{g_j}{2^{j/2}}$)

l the length of the filter, and j the level of decomposition.

The MODWT enables performing a multi-resolution analysis (MRA), which decomposes the time series into a sum of simpler time series, smooths S_j that captures the low-frequency dynamics,

and detail D_j that capture the higher frequency characteristics. Hence, the original time series can be expressed as CITATION And15 \1 1036 (Andries, Ihnatov, & Tiwari, 2015) :

$$X = \sum_{j=1}^{j-1} S_j + D_j$$

Where " j " is the number of multi-resolution levels.

Wavelet analysis has been widely used in financial and economic time series due to its ability to analyze non stationarity, multi-resolution structures, and market co-movements. Studies have applied wavelet methods to examine international stock markets, commodity prices, and economic fluctuations.

II-2- The Multi-Resolution Analysis (MRA) and the Wavelet Variance:

The Multi-Resolution Analysis (MRA), also known as the pyramid algorithm, is a hierarchical extension of the Discrete Wavelet Transform (DWT). It involves decomposing the original signal into m levels by iteratively translating and convolving the mother wavelet with low-pass (LP) and high-pass (HP) filters. These filters preserve the approximation (A) and detail (D) components. The original signal can be reconstructed by summing the final approximation component with all the detail components.

Multi-resolution wavelet analysis makes possible a scale-dependent variance decomposition of a signal. First, the time series $x = \{x_i\}$ is projected on a wavelet basis, yielding wavelet coefficients. The wavelet basis is itself generated by translating and scaling a mother wavelet function noted $\psi(t)$. In practice, these coefficients are computed by a discrete wavelet transform. Let's note S the maximal scale of the analysis. For each scale $s = 1, \dots, S$ one has N_s wavelet coefficients available, given by: (Daubechies, 1992)

$$W_{s,n} = 2^{-\frac{s}{n}} \sum_{i=0}^{L-1} x_i \psi(2^{-s}i - n)$$

For $n = 0, \dots, N_s - 1$ and with L the length of the signal. If the length of the signal is a power of 2, then the number of coefficients per scale is $N_s = L/2^s$. Small scales correspond to high frequencies and large scales to low frequencies of the signal.

After that, the corresponding wavelet coefficients are used to obtain the wavelet variance for a given scale, and are defined as follows:

$$\sigma_{\text{wav}}^2(s) = \frac{1}{2^s N_s} \sum_{n=0}^{N_s-1} [W_{s,n} - \sum_{n=0}^{N_s-1} W_{s,n}]^2$$

III-Wavelet Analysis for Public Expenditure Growth in Algeria:

Wavelet Analysis is a powerful tool used for time series analysis by decomposing the signal into its components at different frequency levels, allowing for the study of temporal patterns across multiple scales.

III-1-MODWT MRA application for Public Expenditure Growth :

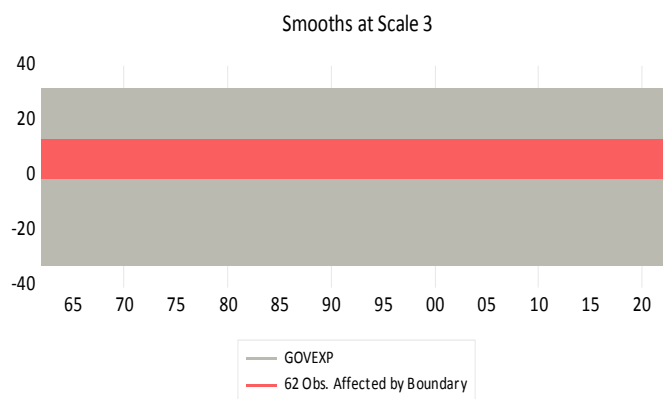
The study applies the Maximal Overlap Discrete Wavelet Transform Multi-Resolution Analysis (MODWT MRA) to examine the growth of public expenditure in Algeria over time. This method allows for the decomposition of the time series into components at different frequency levels, enabling a better understanding of short-term and long-term fluctuations.

The analyzed time series focuses on GOVEXP, representing the growth of public expenditure in Algeria (Data from WDI). To achieve a more refined decomposition, the study employs MODWT MRA, an advanced version of traditional wavelet analysis that overcomes certain limitations, such as the requirement for sample lengths to be powers of two. This approach preserves all observations without the need for padding, enhancing the accuracy of frequency analysis. The decomposition is performed at three frequency levels, allowing for a detailed breakdown of fluctuations in public expenditure. The first level (W1) captures short-term volatility, reflecting rapid changes in government spending. The second level (W2) identifies medium-term fluctuations, corresponding to short- and medium-term economic cycles. The third level (W3) represents long-term trends, highlighting sustained shifts in fiscal policy.

For improved precision in detecting hidden patterns within the data, the study employs the Daubechies 20 wavelet filter, which offers greater smoothness and accuracy compared to the previously used Daubechies 4. This selection enhances the ability to capture subtle variations in expenditure dynamics. The dataset spans the period from 1962 to 2023, covering 62 years of data. This extensive time frame provides a comprehensive foundation for a long-term analysis of public expenditure growth, allowing for deeper insights into the evolution of fiscal policies and economic fluctuations over different periods.

III-1-1-Long-term trend analysis (Scale 3 - Level 3):

Figure n°1: Smooths at Scale 3



Source: Eviews 13 Outputs

Figure n°1 represents the wavelet analysis at Scale 3, which reflects the long-term trends in public expenditure growth in Algeria. At this level, short- and medium-term fluctuations are filtered out, allowing us to observe the overall trend and major patterns.

During the 1970s, a clear upward trend is evident, with public expenditure growth reaching high levels. This period coincides with the oil boom between 1973 and 1979, which led to a

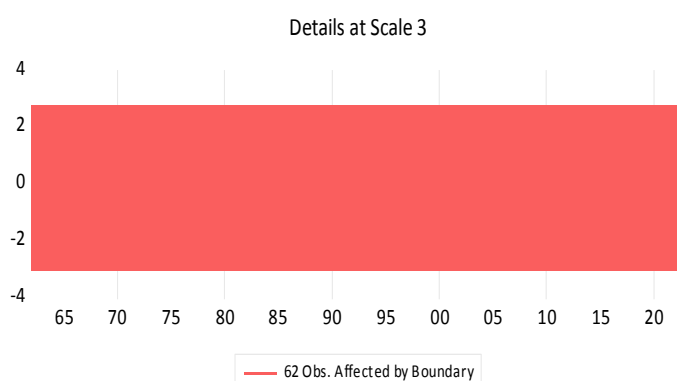
significant increase in government revenues and, consequently, higher spending. While some fluctuations are present, they remain within an overall rising trajectory.

After 1980, the curve shows a gradual decline in public expenditure, indicating a reduction in government spending. This corresponds to the sharp drop in oil prices in the mid-1980s, particularly in 1986, which triggered a severe economic crisis in Algeria. Between 1990 and 2000, the trend stabilizes at relatively low levels due to the lingering effects of the economic downturn and the implementation of austerity measures. Entering the new millennium, public expenditure growth appears to stabilize, with fewer fluctuations compared to previous decades. This suggests that the government adopted more cautious fiscal policies while continuing to be influenced by oil price trends and budgetary constraints.

The dotted red line marks observations affected by boundary effects, meaning that values at the beginning and end of the time series may be less accurate due to smoothing effects. Consequently, results for the early years (1965-1970) and the most recent period (2015-2023) should be interpreted with caution. Overall, the long-term trend reveals that public spending in Algeria was high during the 1970s, declined significantly throughout the 1980s and 1990s, and later stabilized in the 2000s. These shifts can be closely linked to fluctuations in oil prices, economic crises, and the fiscal policies implemented by the Algerian government.

III-1-2-Analysis of Details at Scale 3:

Figure n°2: Details at Scale 3



Source: Eviews 13 Outputs

Figure n°2 represents the detailed series at Scale 3 using wavelet analysis. Unlike the previous graph, which illustrated the long-term trend (Smooths at Scale 3), this one focuses on the cyclical variations and remaining fluctuations at this level. The graph reveals clear cyclical fluctuations, with recurring peaks and troughs in public expenditure growth. This indicates that government spending in Algeria is influenced by periodic factors such as economic fluctuations, oil price cycles, and fiscal policies. These patterns suggest a strong link between public expenditure and external economic conditions.

The period between 1965 and 1995 shows pronounced and more intense fluctuations. This aligns with oil crises, phases of rapid expenditure growth, and shifts in government policies. The strong variations during this time reflect the economic volatility Algeria experienced due to external shocks and domestic policy shifts. After 2000, the fluctuations become less pronounced, suggesting

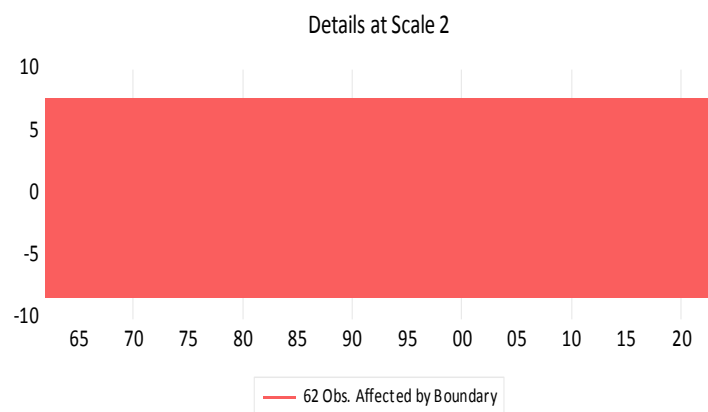
a relative stabilization of public expenditure. This reduced volatility could be attributed to financial reforms or improved budget management. The shift toward a more stable fiscal approach may indicate a more structured and strategic approach to public spending.

The red boundary effects indicate that observations at the edges of the time series may be less reliable. Therefore, values at the beginning and end of the series should be interpreted with caution, as they might be influenced by smoothing effects inherent in wavelet analysis.

This analysis suggests that public expenditure growth in Algeria was more volatile in the past but has become more stable in recent decades. These fluctuations can be linked to economic cycles and oil price changes, where increases in oil revenues have historically driven government spending. While this level of analysis does not show the overall trend, it highlights the long-term economic cycles and fluctuations in public expenditure.

III-1-3-Details at Scale 2 Analysis:

Figure n°3: Details at Scale 2



Source: Eviews 13 Outputs

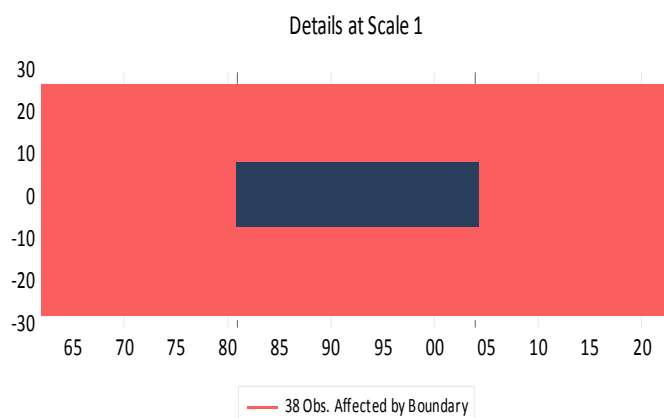
Figure n°3 presents the details of public expenditure in Algeria at Scale 2 using wavelet analysis. These details capture short- to medium-term variations in the time series, which are faster than those observed at Scale 3 but slower than those at Scale 1.

A significant increase in fluctuations can be observed between 1975 and 1985. This period appears to be characterized by sharp variations in public expenditure, likely influenced by economic policies, financial crises, or changes in oil prices. Around 1980, particularly strong fluctuations are noticeable, suggesting the presence of an economic crisis or a sudden shift in government spending.

After 1985, the fluctuations become more regular and less intense compared to the previous decade. This shift may indicate greater stability in economic policies or improved control over public expenditure. The more predictable nature of the variations suggests a transition towards a more structured fiscal approach. Despite the decline in volatility compared to earlier periods, fluctuations continue to persist beyond 2000. This indicates that short-term changes still influence public expenditure growth, possibly due to annual financial policy adjustments. Even with broader economic stability, periodic shifts in fiscal strategies and external economic factors contribute to ongoing variations in spending patterns.

III-1-4-Details at Scale 1 Analysis:

Figure n°4: Details at Scale 1



Source: Eviews 13 Outputs

Figure n°4 presents the analysis at Scale 1 using wavelet analysis, which reveals high-frequency fluctuations or short-term changes in public expenditure (GOVEXP).

During the period from 1965 to 1980, the graph shows strong and turbulent fluctuations in public spending. This period coincides with Algeria's major developmental policies after independence, fluctuations in oil prices, particularly following the 1973 crisis, and the country's heavy reliance on oil revenues, which led to sharp variations in the national budget.

Between 1980 and 2000, the fluctuations begin to decline, leading to a relatively more stable period. This aligns with the 1986 oil crisis, which resulted in a significant reduction in government expenditure, and structural reforms in the 1990s that made public spending more conservative. From 2000 to 2015, public expenditure increased again during the new oil boom. However, the fluctuations were less intense than in the 1970s, suggesting improved control over fiscal policy while still maintaining a reliance on oil revenues.

After 2015, following the 2014 oil price crash, there is a noticeable decline in fluctuations. This can be attributed to the drop in oil revenues and its impact on government spending, the adoption of more cautious and austere fiscal policies, and the search for alternative financing mechanisms such as unconventional monetary policies.

Overall, fluctuations at Scale 1 indicate that short-term changes in Algeria's public expenditure have been closely linked to shifts in oil prices and economic policies. Periods of oil crises or structural reforms resulted in reduced fluctuations due to austerity measures, while high oil prices led to strong fluctuations driven by expanded government spending. Currently, the observed fluctuations suggest an effort to achieve financial stability with greater control over expenditures.

III-2-Wavelet Analysis of Variance:

Wavelet analysis of variance helps determine the extent to which changes occur across different time scales, revealing how variance (fluctuations) is distributed over various time periods. This

technique is particularly useful in economic data analysis as it helps understand the nature of economic fluctuations and whether they are short-term or long-term.

-If most of the variance appears at smaller scales (Scale 1 and Scale 2), this indicates that government spending in Algeria is influenced by short- and medium-term changes, such as short-term fiscal policies or fluctuations in oil revenues .

- However, if the largest variance is observed at Scale 3, this suggests that long-term trends are driving government spending, such as structural economic reforms or changes in development strategies.

III-2-1-Analysis of Variance Across Different Scales:

Table n°1: The wavelet variance distribution

Scale	Variance	Rel. Proport	Cum. Proport
W1	18.32817	0.5697	0.5697
W2	10.21378	0.3175	0.8872
W3	3.627610	0.1128	1.0000

Source: Eviews 13 Outputs

The variance analysis of public expenditure (GOVEXP) across three time scales using wavelets provides insight into the extent of fluctuations at each level, helping to identify the nature of variations in the data. Variance represents the degree of fluctuation in each time scale, with higher values indicating greater instability. The relative proportion shows the contribution of each scale to the total variance, while the cumulative proportion reflects how variance accumulates across different scales until reaching 100%.

The results highlight that short-term fluctuations (W1) are the most significant, accounting for approximately 57% of total variance. This suggests that public expenditure in Algeria is highly responsive to short-term shocks, such as changes in oil prices, annual budget decisions, or emergency spending. Medium-term fluctuations (W2) remain substantial, representing around 32% of the variance, indicating the presence of expenditure cycles extending over several years due to developmental projects and public economic plans. In contrast, long-term fluctuations (W3) are limited, contributing only 11% to the total variance. This suggests that public expenditure follows relatively stable long-term trends, adapting to economic conditions without undergoing drastic structural changes.

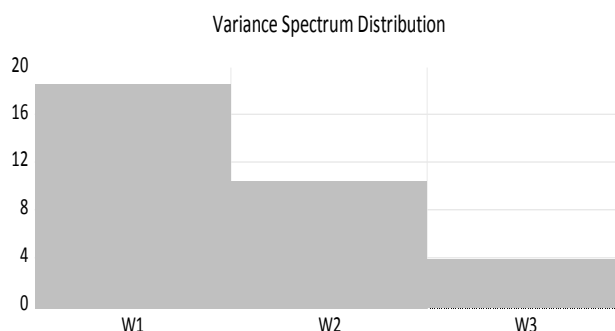
The Algerian economy's reliance on oil revenues explains the high short-term variance, as public expenditure is highly sensitive to oil price fluctuations. Any rapid increase or decline in oil revenues directly influences government financial decisions. The considerable short- and medium-term variance also reflects fiscal instability, driven by shifts in financial policies, subsidy programs, and public investments. However, the low long-term variance suggests a relatively stable overall trend in public expenditure.

To enhance fiscal stability, Algeria could implement strategies that reduce short- and medium-term volatility, such as diversifying revenue sources, improving budgetary policies, and adopting more sustainable long-term financial planning. While policies like the Revenue Regulation

Fund and foreign currency reserves help mitigate short-term fluctuations, they primarily function as shock absorbers rather than long-term solutions. A more resilient approach would focus on structural reforms that stabilize expenditure patterns beyond short-term economic shifts.

III-2-2-Variance Spectrum Distribution:

Figure n°5: Variance Spectrum Distribution



Source: Eviews 13 Outputs

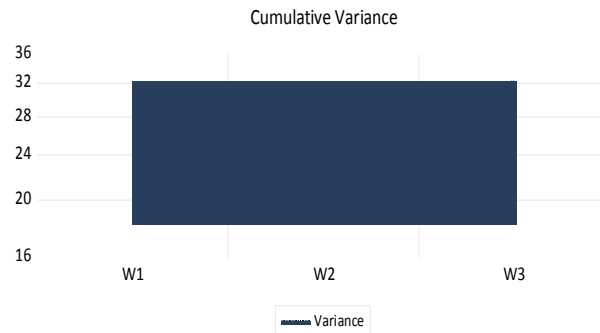
Figure n°5 illustrates the distribution of variance across the three time scales (W1, W2, W3) derived from wavelet analysis. The variance reflects the degree of fluctuations in government expenditure (GOVEXP) over different time horizons.

The results indicate that short-term fluctuations (W1) are the most dominant. The first column (W1) is the highest, showing that most public expenditure variations occur in the short term. This highlights the sensitivity of government spending to sudden changes, such as oil price fluctuations, annual budget decisions, or unexpected economic events. Medium-term fluctuations (W2) remain significant, as represented by the second column, which is lower than W1 but still accounts for a substantial share of the variance. This suggests that medium-term economic factors, such as strategic planning, funding cycles, or multi-year financial reforms, also influence government expenditure. In contrast, long-term fluctuations (W3) are limited, with the third column being the smallest. This indicates that public spending follows a relatively stable long-term trend, with no major financial policy shifts occurring over extended periods.

The findings suggest that government expenditure is highly sensitive to short-term economic conditions, emphasizing the need for flexible fiscal policies to absorb economic shocks. The presence of medium-term effects reflects the role of financial planning and public investments, requiring a dynamic approach to budget management. The relative stability in the long run suggests that achieving better fiscal sustainability is possible by controlling short- and medium-term fluctuations.

III-2-3-Cumulative Variance:

Figure n°6: Cumulative Variance



Source: Eviews 13 Outputs

Figure n°6 represents the cumulative variance across the three time scales (W1, W2, W3), where variance is gradually accumulated to illustrate the overall contribution of each component.

The cumulative variance rises sharply at W1, indicating that the largest share of variance comes from short-term fluctuations. This reflects a high responsiveness of government expenditure to sudden changes, such as economic crises, financial shocks, or fluctuations in commodity prices. As the variance continues to grow at W2, albeit at a slower pace, it highlights the effects of medium-term financial planning, where fluctuations persist but with less intensity than in W1.

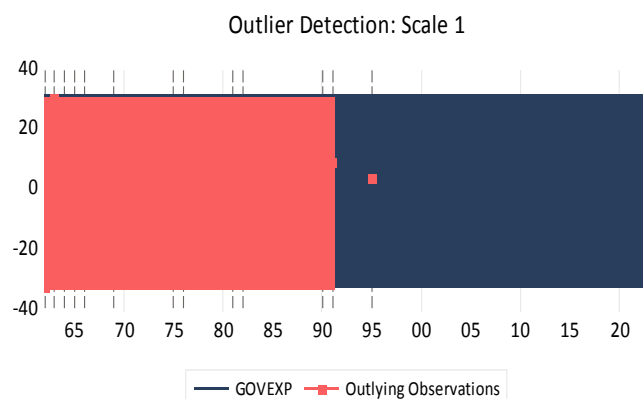
At W3, the variance reaches a stable level, meaning that long-term fluctuations are relatively limited. This suggests the presence of a relatively stable financial trend over extended periods, reinforcing the idea that while short- and medium-term changes impact public spending, the overall long-term trajectory remains steady.

III-3- Detection of Outliers Using the Bilen-Huzurbazar Method:

This analysis applies the MODWT technique to detect outliers in Algeria's government expenditure (GOVEXP) from 1962 to 2023. Using the Daubechies 4 wavelet filter, it decomposes the series into three frequency levels while applying reflective boundary treatment to reduce signal distortion. A soft thresholding method with a universal statistical threshold helps eliminate noise while preserving significant fluctuations. The variance of wavelet coefficients is estimated using the median approach, enhancing robustness against outliers. The Bilen-Huzurbazar method effectively identifies irregular shifts, making it a reliable tool for detecting anomalies in economic data.

III-3-1-Analysis of Outliers - Scale 1:

Figure n°7: Outliers Detection - Scale 1



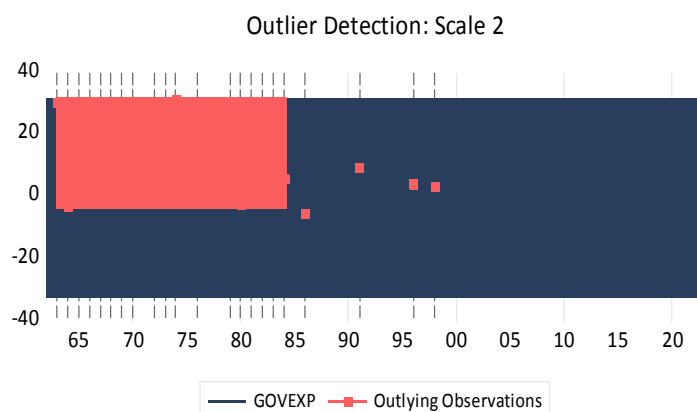
Source: Eviews 13 Outputs

In the Figure n°7 the dashed blue line represents the fluctuations in Algeria's government expenditure over time, illustrating the overall trend in spending. The red dots connected by vertical lines indicate the outliers detected through wavelet analysis, highlighting significant deviations from the general pattern. Scale 1 reflects short-term variations or rapid fluctuations in the data, capturing sudden shifts in government expenditure.

Outliers appear frequently during the 1960s and 1970s, a period marked by major economic transitions in Algeria following independence. Additional anomalies are observed in the 1980s and 1990s, corresponding to economic turbulence caused by oil crises and structural adjustment policies. After 2000, the occurrence of outliers gradually decreases, suggesting a relative stabilization of financial policies. These results align closely with key economic events. The 1960s and 1970s were characterized by nation-building efforts, where expansionary economic policies led to sharp spending fluctuations. The 1980s saw the onset of an economic crisis following the 1986 oil price collapse, forcing Algeria into structural adjustments under IMF guidance. The 1990s were marked by political and security instability, which significantly impacted public finances. After 2000, relative stability emerged due to rising oil prices and increased government spending on infrastructure and social welfare programs.

III-3-2-Analysis of Outliers - Scale 2:

Figure n°8: Outliers Detection - Scale 2



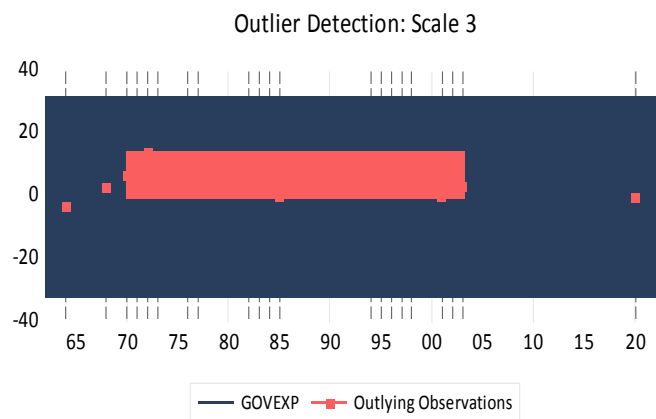
Source: Eviews 13 Outputs

In the Figure n°8 the dashed blue line represents changes in Algeria's government expenditure over time, while the red dots connected by vertical lines indicate outliers detected through wavelet analysis. Scale 2 reflects medium-term fluctuations, capturing expenditure dynamics over several years.

Outliers are concentrated between 1965 and 1985, suggesting sharp fluctuations in government spending policies during these decades. A decline in detected outliers after 2000 indicates relative stability, which may be linked to rising oil prices during that period. In the 1960s and 1970s, Algeria adopted a state-directed economic model following independence, leading to significant public spending on infrastructure and industry. The 1980s saw a severe financial crisis following the 1986 oil price collapse, forcing Algeria to restructure its expenditures and accumulate debt. The 1990s were marked by political and economic instability due to the security crisis and economic reforms. After 2000, relative stability was achieved as improved oil revenues allowed for increased public spending on development projects.

III-3-3-Analysis of Outliers - Scale 3:

Figure n°9: Outliers Detection - Scale 3



Source: Eviews 13 Outputs

In the Figure n°9 the dashed blue line represents changes in Algeria's government expenditure over time, while the red dots connected by vertical lines indicate outliers detected at scale 3 using wavelet analysis. Scale 3 reflects long-term trends in public spending, making it particularly useful for identifying major economic shocks and long-term fiscal policies.

A significant concentration of outliers appears between 1965 and 1985, highlighting substantial fluctuations in government spending during the period of state-building and heavy reliance on oil revenues. The 1990s and early 2000s also show some outliers, though they are less frequent than in previous decades, reflecting the impact of economic reforms. After 2010, a relative stabilization is observed, with fewer detected outliers, possibly indicating more cautious fiscal management.

In the 1970s, soaring oil prices led Algeria to massive spending on industrialization and national projects. The 1980s saw a financial crisis following the 1986 oil price collapse, explaining the presence of multiple outliers during that time. The 1990s were marked by economic and political turmoil, disrupting fiscal policies, which is reflected in the detected anomalies. After 2000,

improved oil revenues contributed to more stable spending, though some outliers remain, particularly during oil crises such as the 2014 downturn.

Conclusion:

After analyzing the behavior of public expenditure in Algeria using wavelet analysis, several findings can be drawn that help assess the validity of the hypotheses proposed at the beginning of the study. The results of Wavelet Variance Analysis revealed that fluctuations in government spending are not uniform over time but vary depending on the time horizon (short, medium, and long term). The results of Outlier Detection also showed that periods of major economic shocks, such as financial crises, oil price collapses, and changes in economic policies, led to significant increases in volatility.

The first hypothesis was confirmed, as the study demonstrated that public expenditure in Algeria exhibits high volatility in the short term, particularly during periods of sharp fluctuations in oil prices. Wavelet analysis results indicated that most of the variance in public spending is concentrated in high-frequency components (W1 and W2), suggesting that government spending is highly sensitive to short-term economic shocks. The second hypothesis was also validated, with findings indicating that public expenditure becomes more stable in the long run, as the variance in low-frequency components (W3) decreases. This reflects government efforts to maintain relative fiscal balance, particularly following periods of excessive spending during financial booms.

The third hypothesis was supported by the results of outlier detection, which confirmed that major economic crises and changes in fiscal policies lead to sharp increases in public expenditure volatility. For example, the data showed notable increases during periods of oil crises, financial reforms, and policy adjustments, confirming that the government resorts to significant increases in public spending as a response to economic shocks. The fourth hypothesis was also verified, as the study demonstrated that wavelet analysis is an effective tool for detecting critical periods in the evolution of public expenditure. This methodology allowed for a better understanding of fluctuations across different time horizons, while the Wavelet Shrinkage Estimator helped filter out statistical noise, enabling the identification of true trends in public spending.

These findings carry important policy implications. Given that the analysis highlighted the significant impact of economic shocks on public expenditure, it is essential for the government to adopt proactive and flexible fiscal policies to mitigate the negative effects of such shocks, such as establishing reserve funds to be used in times of financial emergencies. Reducing dependence on oil revenues is also crucial, as the results confirmed that public spending in Algeria is closely linked to oil price fluctuations, necessitating the diversification of revenue sources to minimize exposure to external shocks. Additionally, the study underscored the importance of using dynamic financial analysis in policy design. The application of advanced analytical tools such as wavelet analysis allows for a more precise understanding of economic trends, enabling the formulation of more effective and well-informed fiscal policies.

In conclusion, the study found that public expenditure in Algeria is characterized by high short-term volatility and relative long-term stability but remains vulnerable to economic shocks, particularly those related to oil prices. The results also highlighted the significance of wavelet analysis in explaining the dynamics of public spending, paving the way for further research that employs this methodology to study rentier economies and assess the impact of fiscal policies on economic stability.

Referrals and references:

1. Albrekt, L. (2007). How Welfare Regimes Generate and Erode Social Capital: The Impact of Underclass Phenomena. *Comparative Politics*, 40(1), pp. 83-101.
2. Aguiar-Conraria, L., & Soares, M. (2011). Oil and the macroeconomy: Using wavelets to analyze old issues. *Empirical Economics*, 40(3), pp. 645-655.
3. Benard, J. (2016). *Économie publique* (FeniXX réédition numérique ed.). Paris: Economica.
4. Benhmad, F. (2012). Modeling Nonlinear Granger Causality between the Oil price and U.S Dollar: a Wavelet based Approach. *Economic Modelling*, 29(4), pp. 1505–1514.
5. Daubechies, I. (1992). *Ten lectures on wavelets*. PHILADELPHIA, PENNSYLVANI: Society for industrial and applied mathematics.
6. Dutu, R. (2016). Raising Public Spending Efficiency in Switzerland,. *OECD Publishing*.
7. Galí, J., López-Salido, J., & Vallés, J. (2004). UNDERSTANDING THE EFFECTS OF GOVERNMENT SPENDING ON CONSUMPTION. *International Research Forum on Monetary Policy* (pp. 1-56). Frankfurt, Germany: European Central Bank.
8. Klein, M., & Linnemann, L. (2023). The composition of public spending and the inflationary effects of fiscal policy shocks. *European Economic Review*, 155, pp. 104-460.
9. Llau, P. (1996). *Économie financière publique*. Paris: Presses universitaires de france.
10. Muzellec, R. (1995). *Finances publiques* (Vol. 9). Paris: SIREY Editions.
11. Peacock, A., & Scott, A. (2000). The Curious Attraction of Wagner's Law. *Public Choice*, 102, pp. 1-17.
12. Percival, D., & Walden, A. (2006). *Wavelet Methods for Time Series Analysis* (Vol. Volume 4). Cambridge, UK: Cambridge University Press.
13. Pinho, C., & Madaleno, M. (2009). Time frequency effects on market indices: world commovements. *Finance International Meeting AFFI-EUROFIDAI*, (pp. 1-22). Paris.
14. Rowley, C., & Tollison, R. (1994). Editor's Note: Peacock and Wiseman on the Growth of Public Expenditure. *Public Choice*, 78(2), pp. 125-128.
15. Rua, A., & Nunes, L. (2009). International comovement of stock market returns: A wavelet analysis. *Journal of Empirical Finance*, 16(4), pp. 632-639.
16. Tiwari, A., Mutascu, M., & Albulescu, C. (2016). Continuous wavelet transform and rolling correlation of European stock markets. *International Review of Economics & Finance*, 42(C), pp. 237-256.