Analysis of the Dynamics of the Algerian Dinar Exchange Rate Using Wavelet Analysis

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Abstract :

Wavelet analysis revealed that fluctuations in the Algerian dinar's exchange rate are not random but reflect the impact of macroeconomic factors over the long, medium, and short terms. The exchange rate is closely linked to oil price cycles, with increases leading to stability and declines causing depreciation. The results also confirm the influence of internal factors, such as inflation and monetary policies, as well as external shocks like global financial crises. The hypotheses were validated, showing that central bank interventions, including foreign reserve management and partial floating policies, played a key role in shaping exchange rate behavior. Achieving long-term stability requires economic diversification and strengthening monetary policy to mitigate volatility.

Keywords: exchange rate, Wavelet analysis, Algerian economy, Algerian Dinar, monetary policies.

JEL classification codes: C42 ; E42; F31

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Introduction:

The exchange rate is one of the most important economic indicators that reflects a country's economic strength and its interaction with both domestic and international variables. In Algeria, the exchange rate of the dinar is heavily influenced by oil revenues and macroeconomic developments, making it vulnerable to sharp fluctuations resulting from external shocks and changes in economic policies.

Over the past decades, the Algerian dinar has experienced a continuous downward trend against foreign currencies, affected by falling oil prices, a trade balance deficit, and the level of foreign currency reserves. Despite interventions by the Bank of Algeria and economic reform strategies, the exchange rate still suffers from structural and cyclical fluctuations, raising questions about the actual factors controlling its trajectory.

In this context, wavelet analysis provides a powerful analytical tool for understanding exchange rate dynamics, allowing for the study of changes across different time horizons (short, medium, and long-term). This research aims to apply the MODWT MRA wavelet analysis to examine the nature of the Algerian dinar exchange rate behavior since independence and the factors influencing its fluctuations. Specifically, how have internal and external factors contributed to the dynamics of the exchange rate over time? This leads us to the central question: What are the main factors driving the behavior of the Algerian dinar exchange rate from independence to the present day?

To address this, several hypotheses are proposed: first, that fluctuations in the dinar's exchange rate reflect the impact of domestic economic policies, such as Algeria's dependence on oil revenues and efforts to maintain financial stability. Second, external factors, including oil price volatility and international economic relations, have played a significant role in shaping the stability or volatility of the dinar.

Furthermore, the third hypothesis suggests that monetary policies implemented by Algeria, such as adjustments to foreign exchange reserves and external financing strategies, have been key in determining the exchange rate behavior. Lastly, government actions, such as devaluation or exchange rate liberalization, have had a direct impact on economic growth, either stimulating or restricting it. These hypotheses aim to provide a comprehensive understanding of the driving forces behind the Algerian dinar’s exchange rate movements.

I. Literature Review:

The real exchange rate is defined as the ratio of foreign prices to domestic prices, both measured in the same currency, or alternatively, as the nominal

exchange rate adjusted by relative prices between countries. It serves as a key indicator of a country's competitiveness in international trade.

Given the importance of the real exchange rate, numerous studies have been conducted to identify its determinants. Notable studies include those by Ghura and Grennes, which focused on a panel of Sub-Saharan countries (Ghura, 1993), as well as Cottani et al., Elbadawi and Soto, and Aron et al. for developing countries and South Africa. These studies consistently identified several key determinants of the real exchange rate, including terms of trade, openness, capital inflows, and nominal devaluations (Cottani, Cavallo, & Khan, 1990) (ElBadawi, 1997) (Aron, ElBadawi, & Khan, 1997)

Williamson offers a clear and insightful account of how the concept of the real exchange rate evolved, driven by economists' desire to determine the equilibrium exchange rate. He emphasized that the main motivation behind the study of the real exchange rate has been the search for an appropriate definition of the equilibrium exchange rate and methods to estimate its value. Regardless of the definition used, the equilibrium real exchange rate is understood to be the one that aligns with both the external and internal balance of the economy. Over the past decades, studies on the determinants of the real exchange rate and the consequences of its misalignment have become central to research in the field (Williamson, 1994).

Edwards' approach has made a significant contribution to the study of real exchange rate behavior by adopting a positive approach that seeks to understand the phenomena that define it and how to address them. Edwards developed a model for a panel of 12 developing countries to study and explain the determinants of short- and long-term exchange rates between 1962 and 1985. The results were consistent with the theoretical framework. In the short term, the real exchange rate is affected by both monetary and real variables. These effects continue into the long term through factors such as terms of trade, the level and composition of public spending, capital flow controls, exchange rate controls, technological progress, and capital accumulation.

The short-term results also revealed that the nominal exchange rate, domestic credit supply, and real fundamentals are key determinants of the real exchange rate. The coefficients for terms of trade, government spending relative to GDP, exchange controls, and trade were negative, while the coefficient for technological progress was positive (Edwards, 1989).

The factors that determine the value of the real exchange rate have expanded over time to include production levels, inflation rates, the degree of economic openness, interest rates, domestic and foreign money supply,

exchange rate regimes, and central bank independence (Stancik, 2007). The impact of these factors is closely linked to the economic situation in each country. In this context, various economic studies have consistently agreed that the real equilibrium exchange rate cannot be precisely determined by the Purchasing Power Parity (PPP) theory, as the exchange rate tends to move slowly toward equilibrium in the long run (Macdonald, 2003)

(Carrera & Restout, 2008) provided a comprehensive review of the literature on the determinants of the real exchange rate, identifying key long-term drivers such as the Balassa-Samuelson effect, government spending, terms of trade, openness, foreign capital flows, and the nominal exchange rate regime. These issues remain the subject of ongoing debate among researchers. (Juthathip, 2009) found that in developing Asian countries, the real exchange rate is determined by five key medium- to long-term variables: productivity differentials, openness, terms of trade, net foreign assets, and government spending.

Furthermore, A. Kula and H. Kalyoncu (2010) supported the existence of the long-run Purchasing Power Parity (PPP) hypothesis in Turkey by using both black market and official exchange rates. Bahmani-Oskooee et al. (2013) employed the Sequential Panel Selection Method (SPSM) to examine the PPP hypothesis and found strong evidence for its long-run validity for a group of BRICS (Brazil, Russia, India, China, and South Africa) and MIST (Mexico, Indonesia, South Korea, and Turkey) countries, using monthly real effective exchange rate (REER) data from January 1994 to June 2012. (Bahmani, Chang, & Kuei-Chiu, 2013)

II. Algerian Exchange Rate Policy:

The evolution of Algeria's exchange rate from independence until now can be summarized in the following periods:

1. 1964-1986 period:

In 1964, the Algerian dinar was pegged to 0.18 grams of gold, with parity to the French franc. However, after the French franc was devalued in 1969, the dinar's exchange rate remained fixed, leading to a gradual decline in its value due to the depreciation of the French franc. This, along with rising import costs, prompted a reevaluation of investment projects under the First Four-Year Plan (1970-1973). As Algeria shifted away from the Bretton Woods system, a new pricing system was introduced in 1974-1977 to support public institutions and protect them from exchange rate volatility.

From 1974 to 1986, the dinar's value was based on a basket of 14 currencies, with the US dollar playing a dominant role. The Central Bank of

Algeria determined the exchange rate according to the composition of the country's external payments.

2. 1986 – 1994 period:

A slight adjustment to the dinar's exchange rate was introduced during this period, adjusting the relative value of currencies within the dinar's basket, setting the stage for the new exchange rate policy implemented in March 1987.

Following a sharp decline in oil prices in 1986, Algeria faced an economic crisis, marked by a budget and balance of payments deficit. This prompted a shift from a planned economy to a market-oriented economy. The dinar was devalued gradually from 1987 to 1992, moving from 4.9 to 17.7 per US dollar. In September 1991, the dinar was further devalued by 22%, and by 1994, the IMF-adjusted rate led to a 40.17% depreciation, setting the rate at 36 dinars per US dollar.

3. 1994 – 2023 period:

Between 1994 and 2018, Algeria devalued the dinar several times. The most significant devaluation occurred in 1994, when the dinar lost 70% of its value in two phases. In 1996, Algeria adopted a managed floating exchange rate, but by the early 2000s, the gap between the official and black market exchange rates had widened significantly, with 40% of business transactions conducted informally. (Bouteldja, Benamar, & Maliki, 2013)

In 2003, the dinar was further devalued by 2-5% to curb the growth of the parallel market. From 2003 to 2013, the dinar fluctuated, depreciating by 19% against the US dollar between 2003 and 2008, and by 4.2% from 2010 to 2013 (SiMohammed, Benhabib, & Zenagui, 2015). In 2017, the dinar depreciated by 3.3% against the euro, and by 1.4% against the US dollar.

By the end of 2018, the exchange rate was 118.29 Algerian dinars per US dollar, and 135.30 dinars per euro, according to the Bank of Algeria. (Bank of Algeria report, 2018). Since 2018, Algeria has faced significant challenges in managing the exchange rate of the dinar, primarily due to fluctuating oil prices, economic instability, and structural issues. In 2018, the dinar's official exchange rate was 118.29 to the US dollar, but by mid-2020, it had depreciated further due to the reduced oil revenues and the country's dependency on imports. The Central Bank of Algeria continued to manage the dinar through a managed floating exchange rate system, adjusting its value gradually instead of letting market forces dictate the exchange rate. (Bank of Algeria, 2019)

The onset of the COVID-19 pandemic in 2020 worsened the economic situation, leading to a further depreciation of the dinar. In response to the economic crisis, the dinar was devalued by approximately 9% in 2021, pushing the exchange rate

to about 145 Algerian dinars per US dollar. Despite this, the black market exchange rate remained higher, reflecting the ongoing shortage of foreign currency and limited convertibility of the dinar. (IMF, 2020)

By 2023, the official exchange rate hovered around 146 to 150 dinars per US dollar, with periodic fluctuations due to global oil price changes. The government has been exploring reforms to diversify the economy beyond hydrocarbons and stabilize the currency. However, the gap between the official and black market rates remains a significant challenge, indicating continued pressure on Algeria's foreign exchange system. (IMF, 2021).

III. The wavelet approaches:

1. The maxima overlap discrete wavelet transform (MODWT):

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:

$$W_{j,t} = \sum_{l=0}^{n-1} \widetilde{h_{j,l}} p_{t-1} mod N \dots\dots\dots\dots\dots\dots\dots\dots\dots eq1$$

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

$$V_{j,t} = \sum_{l=0}^{n-1} \widetilde{g_{j,l}} p_{t-1} mod N \dots\dots\dots\dots\dots\dots\dots\dots\dots eq2$$

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

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 multiresolution 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 \l 1036 (Andries, Ihnatov, & Tiwari, 2015) :

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

Where " j " is the number of multiresolution levels.

2. wavelet correlation and wavelet covariance:

Wavelet correlation is a recent technique in financial time series analysis. The wavelet correlation between two stochastic processes, u and v, is estimated using the MODWT coefficients for each scale $\tau_j = 2^{j-1}$ through:

$$\hat{\rho}_{uv}^{1}(\tau_j) = \frac{cov_{uv}(\tau_j)}{\hat{\delta}_u^2(\tau_j)\,\hat{\delta}_v^2(\tau_j)}$$

$\hat{\delta}_u^2(\tau_j)$ and $\hat{\delta}_v^2(\tau_j)$ represent the wavelet variance of X and Y at scale" j " .

$cov_{uv}(\tau_j)$ is the wavelet covariance at scale " j " , which can be expressed as follows:

$$cov_{uv}(\tau_j) = \frac{1}{\widetilde{N}_j} \sum_{t=L_j-1}^{N-1} \widetilde{d_{j,t}^{u}}\ \widetilde{d_{j,t}^{v}}$$

3. The continuous wavelet transform (CWT):

Wavelet methods are relatively new tools for analyzing non-linear and non-stationary economic and financial data. While they have their roots in Fourier analysis, they overcome the limitations of this method. Wavelet analysis offers advantages over the Fourier method by simultaneously combining information from both the time and frequency domains. (Donoho & Johnstone, 1994)

The Continuous Wavelet Transform (CWT) is widely used for wavelet analysis and is a powerful mathematical tool for analyzing non-stationary time series in the time-frequency domain. For a time series $X(t)$, the Continuous Wavelet Transform (CWT) for a wavelet $\psi(t)$ is defined as:

$$W_{X,\psi}(\tau,s) = \int_{-\infty}^{+\infty} X(t)\frac{1}{\sqrt{|s|}}\psi^{*}\left(\frac{t-\tau}{s}\right)dt \ldots\ldots\ldots\ldots\ldots\ldots eq1$$

Where (τ, s) indicate the time and the frequency domain of the wavelet respectively.

$\psi(t)$ is Morlet wavelet function, consisting of a plane wave modulated by a Gaussian:

$$\psi_0(\mu) = \pi^{-\frac{1}{4}}\ e^{i\omega_0\mu}\ \ e^{-\mu^2/2}$$

The Wavelet Power Spectrum (WPS) of the continuous wavelet transform is defined as:

$$WPS_x(\tau, s) = |W_x(\tau, s)|^2$$

The WPS depicts and measures the local variance of a time series at different time and scales. ((Tastan & Sahin, 2020)

4. Wavelet squared coherence (WSC):

The wavelet squared coherence technique is a valuable tool for analyzing the co-movements between two time series across different time scales and frequency bands.

The wavelet coherence between two time series u and v is defined as:

$$R_t^2(\tau_s) = \frac{|\varepsilon(\tau_s^{-1} W_t^{uv}(\tau_s))|^2}{\varepsilon|(\tau_s^{-1} W_t^{uv}(\tau_s))| . \varepsilon|(\tau_s^{-1} W_t^{uv}(\tau_s))|}$$

Where $R_t^2(\tau_s)$, is the squared wavelet coherence, its value ranges between 0 and 1, and measures the local linear correlation between two time series at a particular scale. Where:

S: is a smoothing operator defined as:

$$S(W) = S_{scale}(S_{time}(W_n(s))$$

Where S_{scale}, represents smoothing along the wavelet scale axis, and S_{time} smoothing in time.

W_n^{uv} : the cross wavelet power, it is viewed as the local covariance of u and v, where $W_n^{uv}(s) = W_n^u W_n^v$, W_n^u, W_n^v are continuous wavelet transform of two time series u(t) and v(t) respectively. (Torrence & Webster, 1999)

The wavelet coherence phase difference is given by:

$$\emptyset_{u,v} = tan^{-1} \frac{I\, W_n^{uv}}{R\, W_n^{uv}} \quad \emptyset_{u,v} \in [-\pi; \pi]$$

Where: I and R are the imaginary and real parts, respectively, of the smoothed cross wavelet power spectrum. Phase differences are indicated by arrows on the wavelet coherence plots. Right-pointing arrows indicate that the time series are in phase, while left-pointing arrows indicate they are in anti-phase. When the arrows point vertically upward, the first time series leads the second. Conversely, downward-pointing arrows indicate that the second time series is leading. (Torrence & Compo, 1998)

IV. Wavelet Analysis through the Maximum Overlap Discrete Wavelet Transform (MODWT) Multi-Resolution Analysis (MRA):

The analysis of the economic dynamics of the Algerian dinar exchange rate relies on a set of macroeconomic factors that interact with each other to determine the currency's trajectory. Using wavelet analysis through the

Maximum Overlap Discrete Wavelet Transform (MODWT) Multi-Resolution Analysis (MRA), it is possible to identify time periods during which the dinar was affected by shocks or long-term trends, allowing for an understanding of the structural and immediate causes of exchange rate fluctuations.

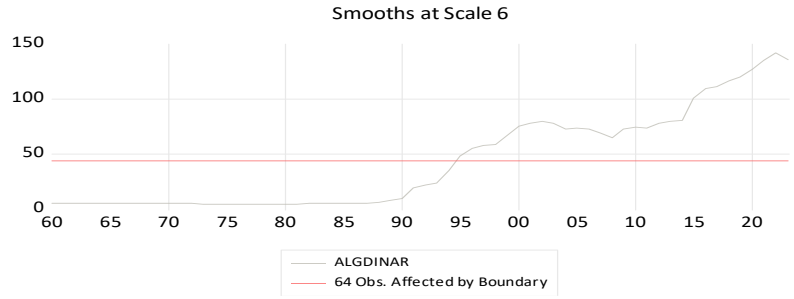
1. The long-term trend:

1.1. Smooths at Scale 6 analysis:

Wavelet analysis at Scale 6 focuses on long-term trends, meaning that this chart reflects the overall trend of the Algerian Dinar (ALGDINAR) after removing short- and medium-term fluctuations. It is observed that before the 1990s, the index was either stable or very low, then began to rise after the 1990s, with a noticeable increase after 2000. The trend continues to rise after 2010, indicating a gradual and long-term increase in the value of the index. Some minor fluctuations appear after 2010, but they are not sharp, indicating a relative stability compared to previous periods.

The analysis shows a long-term downward trend in the value of the dinar, which aligns with the monetary policy adopted in Algeria to address economic crises. The minor fluctuations after 2010 may reflect attempts by the government and the central bank to intervene in the foreign exchange market to maintain stability. After 2020, there appears to be an acceleration in the decline, indicating that the Algerian economy has been significantly affected by recent international conditions. (Refer to figure 1)

Figure (1): Smooth at scale 6



Source: Outputs of the Eviews 13 program application

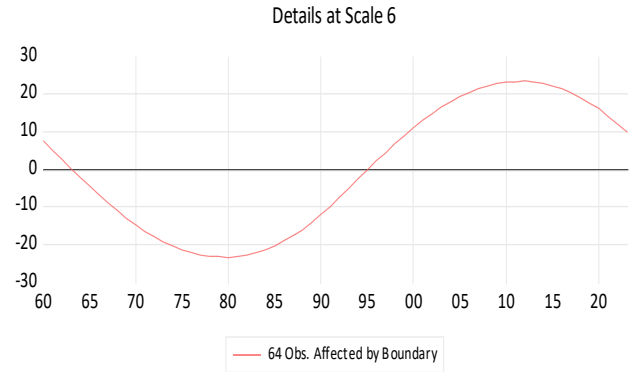
1.2. Details at Scale 6 analysis:

The difference between this figure and the sixth scale is that this analysis captures relatively shorter-term fluctuations, providing a clearer understanding of periods with more noticeable changes. Between 1960 and 1980, exchange rate fluctuations remained low due to strict monetary policies and a planned economy. From 1980 to 2000, volatility increased, driven by economic reforms, partial exchange rate liberalization, and inflationary pressures. Between 2000 and 2020, fluctuations peaked, particularly after 2015, due to falling oil prices

and rising financial pressures. A subsequent decline suggests central bank interventions aimed at stabilizing the exchange rate.

If the current trend continues, a further decline in exchange rate fluctuations may be observed in the coming years. However, new financial crises, significant drops in oil prices, or shifts in monetary policy could trigger a new wave of volatility. The recent decline in fluctuations may indicate the Algerian central bank's control over the foreign exchange market, suggesting a period of relative stability in the near future. (Refer to figure 2)

Figure (2): Details at Scale 6 analysis



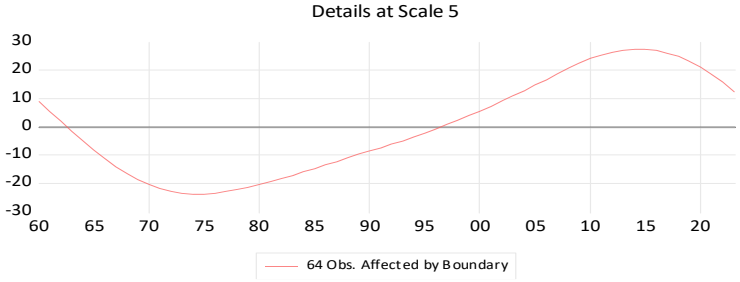
Source: Outputs of the Eviews 13 program application

2. Medium-term cycles (levels 3 - 5):

2.1. Details at Scale 5 analysis:

The analysis captures short-term fluctuations compared to Level 6, providing a clearer understanding of more noticeable temporal changes. Between 1960 and 1980, there was relative stability or a decline in fluctuations, while from 1980 to 2000, fluctuations increased due to economic reforms and inflationary pressures. From 2000 to 2020, there was a period of sharp volatility, coinciding with rising oil prices followed by a decline after 2015. The comparison shows that medium-term fluctuations follow cycles similar to long-term ones. Moving forward, if the current trend persists, we may see a continued reduction in fluctuations, though new volatility could emerge if economic crises or policy changes occur. (Refer to figure 3)

Figure (3): Details at Scale 5 analysis

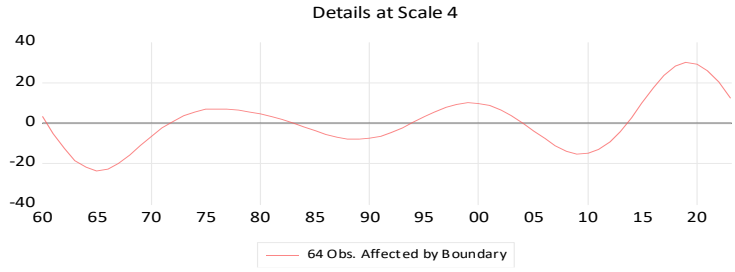


Source: Outputs of the Eviews 13 program application

2.2. Details at Scale 4 analysis:

At level six, we saw long-term changes, while level five involved medium-term fluctuations tied to economic cycles and monetary policies. At level four, fluctuations were faster and shorter, often driven by sudden economic events or market shifts. Between 1960 and 1985, volatility was low, reflecting economic stability. From 1985 to 2000, volatility increased due to economic reforms and global interactions, while from 2000 to 2025, fluctuations became more frequent and intense, driven by external factors like oil prices. The increase in volatility suggests that exchange rates have become more sensitive to short-term economic changes. (Refer to figure 4)

Figure (4): Details at Scale 4 analysis



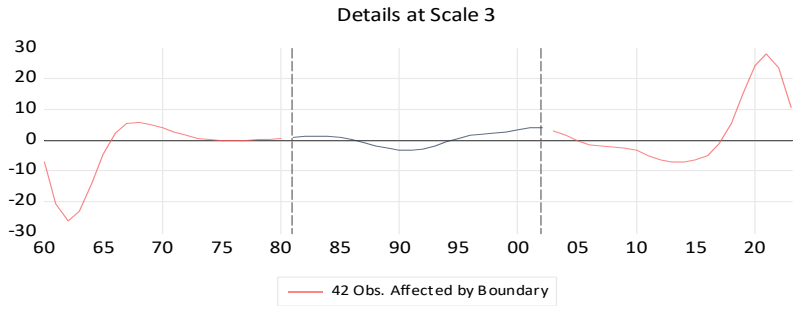
Source: Outputs of the Eviews 13 program application

2.3. Details at Scale 3 analysis:

The figure 5 shows the changes in the exchange rate (ALGDINAR) at the third level of wavelet analysis. This level reflects faster and shorter fluctuations compared to previous levels. The presence of intermittent periods and boundary effects indicates clear instability or sudden changes during certain time periods.

Between 1960 and 1980, we observed noticeable but mild fluctuations, indicating periods of relative exchange rate stability, likely due to fixed exchange rate policies. From 1980 to 2000, there was a clear instability, especially between 1985 and 1995, with fluctuations decreasing during certain periods, possibly due to central bank interventions or tighter control over the exchange market. The presence of interruptions suggests structural changes or economic crises leading to direct market interventions. From 2000 to 2025, there were sharp, short-term fluctuations reflecting the effects of open financial markets, oil price changes, and frequent monetary interventions. In conclusion, the exchange rate has become more sensitive to short-term factors, and analyzing its relationship with variables like inflation, reserves, and monetary policies is essential. (Refer to figure 5)

Figure (5): Details at Scale 4 analysis



Source: Outputs of the Eviews 13 program application

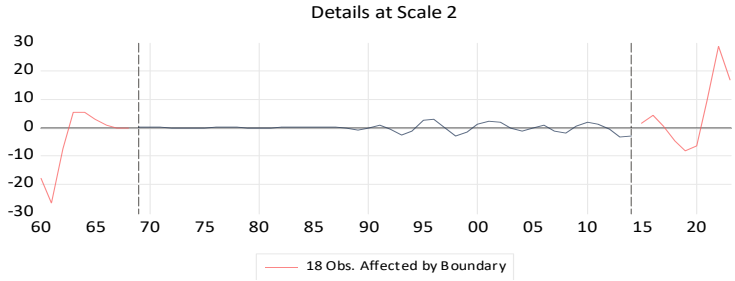
3. Short-term fluctuations (levels 1 - 2):

3.1. Details at Scale 2 analysis:

This level reflects very short-term fluctuations in the exchange rate (ALGDINAR). Compared to previous levels, we observe a decrease in fluctuation activity in the middle, with sharp movements at the boundaries. The presence of 18 observations affected by the boundaries indicates significant instability during the early or late periods of the sample.

Between 1960 and 1970, sharp fluctuations were observed, likely due to strong adjustments in monetary policy or economic disruptions, possibly linked to economic reforms or changes in currency value. From 1970 to 2015, relative stability prevailed, indicating tighter monetary policies or the absence of major external shocks, although small fluctuations suggest ongoing external influences on the exchange rate. Between 2015 and 2025, a sharp rise in fluctuations was observed, potentially tied to economic crises, market disruptions, or significant shifts in exchange rate policy. This may also reflect global events like falling oil prices or local monetary decisions affecting the Algerian dinar. In conclusion, the sharp fluctuations suggest the need for further analysis of the relationship between exchange rate changes and factors such as trade deficits or inflation. (Refer to figure 6)

Figure (6): Details at Scale 2 analysis



Source: Outputs of the Eviews 13 program application

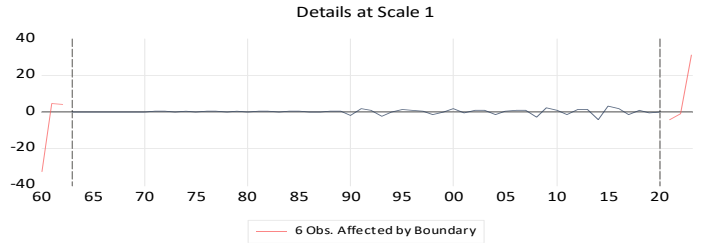
3.2. Details at Scale 1 analysis:

This level reflects noise and immediate (high-frequency) changes in the exchange rate. The chart shows near-complete stability during most periods, with very minor fluctuations. There are 6 observations affected by the

boundaries, which represent areas with unusual fluctuations at the beginning and end.

Between 1960 and 2020, the exchange rate appeared very stable, suggesting that short-term random fluctuations were not strong enough to have a noticeable impact, likely due to effective monetary policies that curbed daily or weekly fluctuations. However, sharp rises in fluctuations were observed at the beginning and end of the period, potentially caused by sudden changes in the monetary system, significant economic events, or market speculation. These sharp spikes highlight the need to examine the economic events that may have triggered such changes. The stability of the exchange rate suggests that major fluctuations affecting the Algerian dinar were long-term rather than short-term. Comparing these results with data like inflation or central bank interventions can provide a clearer understanding. (Refer to figure 7)

Figure (7): Details at Scale 1 analysis



Source: Outputs of the Eviews 13 program application

V. Wavelet Analysis of Variance (WVAR):

1. Explanation of the table outputs:

Determining the variance distribution across different time levels, which helps in understanding the impact of various economic shocks on the exchange rate in the short, medium, and long terms.

Table (1): The wavelet variance distribution

Scale	Variance	Rel. Proport	Cum. Proport.
W1	2.399327	0.0192	0.0192
W2	4.743792	0.0380	0.0572
W3	20.73159	0.1659	0.2231
W4	97.07444	0.7769	1.0000

Source: Outputs of the Eviews 13 program application

The wavelet variance analysis is based on understanding how the total variance is distributed across different time levels. In this case, the Algerian dinar exchange rate was analyzed using the Maximum Overlap Discrete Wavelet Transform (MODWT) up to the fourth level (max scale = 4) using the Daubechies 4 filter. The provided table (1) shows:

- Scale: Represents the time level of the analysis, indicating the duration of the fluctuations.

- Variance: The amount of variance at each level, indicating how much the values differ at that time frame.

- Rel. Proport. (Relative Proportion): The contribution of each time level to the total variance.

- Cum. Proport. (Cumulative Proportion): The cumulative percentage of the total variance up to that level, showing how much of the overall fluctuations are explained by different levels.

2. Analysis of Different Levels:

- Level One (W1) – Very Short-Term Fluctuations (Instantaneous and Temporary Effects): The variance at level one is 2.3993, with a relative proportion of 1.92% and a cumulative proportion of 1.92%. This indicates that short-term fluctuations have a very limited effect on the exchange rate. These fluctuations could reflect temporary changes resulting from sudden political events, momentary market speculation, or changes in liquidity.

- Level Two (W2) – Short-Term Fluctuations (Weeks to Months): The variance at level two is 4.7438, with a relative proportion of 3.80% and a cumulative proportion of 5.72%. This indicates that these relatively short-term fluctuations are more significant than those at level one. They may be linked to changes in currency demand and supply during specific periods, such as during seasonal importation periods or short-term monetary interventions by the central bank.

- Level Three (W3) – Medium-Term Fluctuations (Annual Economic Cycles): The variance at level three is 20.7316, with a relative proportion of 16.59% and a cumulative proportion of 22.31%. This indicates that changes in this time frame represent an important portion of the exchange rate fluctuations. These fluctuations are often associated with changes in inflation, monetary policies, or the effects of seasonal changes in the Algerian economy. They may also reflect fluctuations in oil prices over a year or two, which can impact foreign exchange reserves.

- Level Four (W4) – Long-Term Fluctuations (Major Structural and Economic Factors): The variance at level four is 97.0744, with a relative proportion of 77.69% and a cumulative proportion of 100%. This shows that most of the changes in the Algerian dinar exchange rate occur over the long term. Most of the changes in the Algerian dinar exchange rate occur over the long term, reflecting substantial influences such as global oil prices, given that Algeria relies heavily on oil and gas exports for hard currency. Additionally, structural economic policies, such as decisions to liberalize the exchange rate or significant interventions by the central bank, play a key role. Major economic

shocks, such as global financial crises or changes in trade relations and external debt, also contribute to these long-term fluctuations.

3. Economic Interpretation:

- The significant contribution of long-term fluctuations (77.69%) indicates that the Algerian dinar exchange rate is primarily influenced by long-term macroeconomic factors. This means that any disruption in the oil market or trade balance will have a lasting impact.

- Short-term fluctuations account for only 5.72% of the total variance, suggesting that the dinar is not subject to daily speculation or rapid changes, unlike currencies in fully open markets.

- Medium-term fluctuations (16.59%) reflect cyclical influences such as inflation, interest rate policies, and changes in the money supply. This suggests that monetary interventions can be relatively effective, but they are not the primary factor in determining the long-term trend.

VI. Outlier Detection Analysis Using Bilen-Huzurbazar

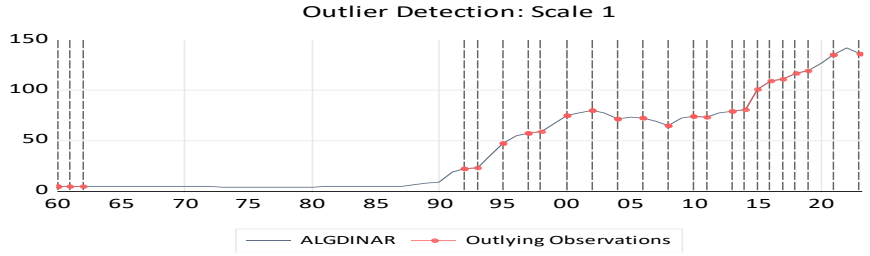
The outlier detection analysis using the Bilen-Huzurbazar method, based on wavelet analysis (MODWT) with Daubechies 4 filter, reveals that there are data points in the Algerian dinar exchange rate series (ALGDINAR) that deviate from the expected general behavior based on the statistical distribution.

1. Outlier Detection Analysis - Level 1 (Scale 1):

By analyzing this scale, we can identify moments where the exchange rate behavior was particularly erratic, providing insight into short-term shocks that might not be captured in broader, longer-term trends.

The periods in which outliers appeared in the Algerian dinar exchange rate coincide with major economic events in Algeria and globally. In the 1990s, Algeria faced a deep economic crisis due to falling oil prices and a transitional phase in economic policy. The early 2000s saw a relative improvement thanks to rising oil prices, though fluctuations persisted. The 2008 global financial crisis was a key factor in increasing volatility due to its impact on the global economy. After 2014, the decline in oil prices once again put significant pressure on the exchange rate, contributing to sharp market fluctuations. (Refer to figure 8)

Figure (8): Outlier Detection (Scale 1)



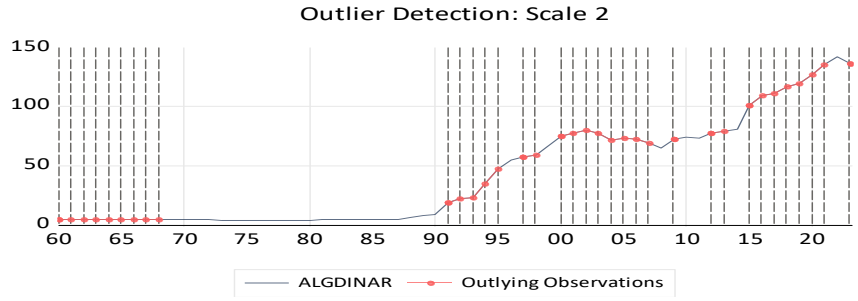
Source: Outputs of the Eviews 13 program application

2. At Level 2 (Scale 2) of the outlier detection analysis:

In this level, the outliers likely correspond to events that cause moderate but noticeable changes in the exchange rate, reflecting the impacts of macroeconomic policy adjustments or significant global economic changes that affect Algeria's financial stability.

In the 1970s and 1980s, this period can be considered one of relative stability in the exchange market compared to the crises that followed. The oil crises of the 1970s indirectly affected the exchange rate, but there were no dramatic changes until the late 1980s. In the 1990s and early 2000s, Algeria faced a financial crisis that led to an increase in outliers, while the period from 2000 to 2004 saw an economic recovery due to rising oil prices, though sharp fluctuations persisted. Since 2014, with the decline in oil prices, outliers increased significantly, reflecting the pressure on the Algerian dinar due to fluctuations in oil revenues, as well as interventions by the central bank in the market. (Refer to figure 9)

Figure (9): Outlier Detection (Scale 2)

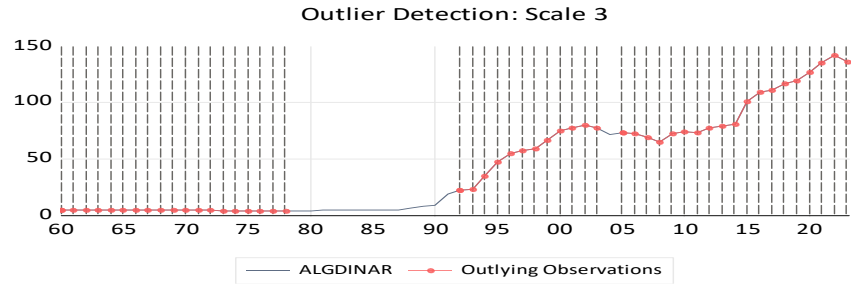


Source: Outputs of the Eviews 13 program application

3. At Level 3(Scale 3) of the outlier detection analysis:

The analysis of outliers shows their concentration in specific periods: the early 1990s, the early 2000s, and post-2014. In the 1990s, outliers indicate sharp fluctuations due to the economic crisis and falling oil prices. From 2000-2005, despite economic improvement due to rising oil prices, fluctuations continued due to economic reforms. After 2014, the sharp decline in oil prices contributed to significant fluctuations, with interventions by the central bank to stabilize the dinar, leading to noticeable outliers. (Refer to figure 10)

Figure (10): Outlier Detection (Scale 3)

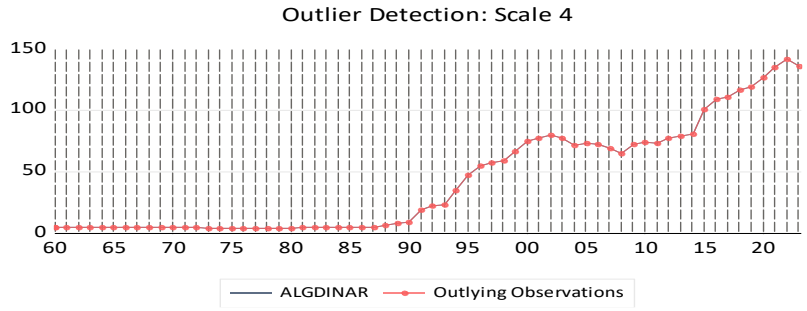


Source: Outputs of the Eviews 13 program application

4. At Level 4(Scale 4) of the outlier detection analysis:

Outliers in the Algerian dinar exchange rate are prominent in specific periods, particularly during the 1970s, late 1990s, and from 2014 to 2023. The 1990s saw significant outliers due to the economic crisis following a sharp drop in oil prices and Algeria's financial struggles. Between 2000 and 2007, while oil prices rose, moderate fluctuations persisted due to economic instability and dependence on oil revenues. From 2014 onwards, falling oil prices caused sharp volatility, increasing the frequency of outliers. Economic reforms were insufficient to stabilize the dinar, leading to heightened pressure on Algeria's economy. (Refer to figure 11)

Figure (11): Outlier Detection (Scale 4)

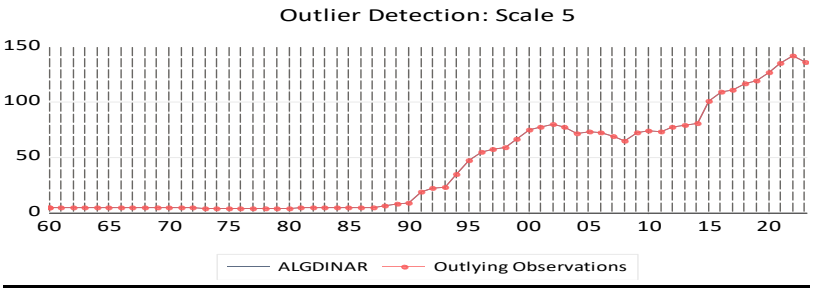


Source: Outputs of the Eviews 13 program application

5. At Level 5 (Scale 5) of the outlier detection analysis:

Outlier analysis reveals significant anomalies in specific periods, particularly in the early 1990s, early 2000s, and from 2014 to 2023. In the 1990s (1990-1995), a major outlier appears in 1992, likely reflecting Algeria’s severe economic crisis due to collapsing oil prices and internal political instability. During 2000-2007, despite rising oil prices, minor outliers indicate moderate exchange rate fluctuations. From 2014 onward, a notable increase in outliers reflects shocks from falling oil prices and government interventions in the exchange market. These trends highlight economic distress, including inflation, declining foreign reserves, and central bank efforts to stabilize the dinar. (Refer to figure 12)

Figure (12): Outlier Detection (Scale 5)

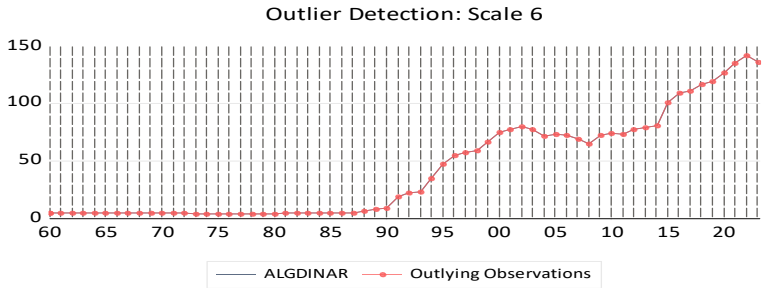


Source: Outputs of the Eviews 13 program application

6. At Level 6 (Scale 6) of the outlier detection analysis:

Outlier analysis reveals anomalies concentrated in specific periods, particularly after 1990, with a significant rise from 2014 to 2023. In the 1990s (1990-1995), major outliers appear in 1992-1993, coinciding with Algeria's economic crisis due to falling oil prices and political instability. During 2000-2007, despite higher oil prices, some outliers indicate moderate fluctuations linked to economic policy shifts. From 2014 onward, a sharp increase in outliers reflects the impact of plunging oil prices, causing severe exchange rate volatility. These trends highlight the economic strain caused by declining oil revenues, monetary policy adjustments, and broader financial instability. (Refer to figure 13)

Figure (13): Outlier Detection (Scale 6)



Source: Outputs of the Eviews 13 program application

VII. Conclusion:

The analysis of the historical developments in the Algerian dinar's exchange rate reveals a strong correlation with major economic events, particularly fluctuations in oil prices. During periods of rising oil prices, the dinar experiences relative stability, whereas sharp declines lead to significant depreciation. This pattern underscores the Algerian economy's heavy reliance on hydrocarbon revenues and its vulnerability to external shocks that directly impact foreign exchange reserves and the balance of payments.

The verification of the proposed hypotheses confirms that exchange rate fluctuations are influenced by both internal and external factors. The first hypothesis, which suggests that domestic economic policies—particularly Algeria's dependence on oil revenues—affect exchange rate movements, is strongly supported by the findings. The long-term trends indicate that the dinar's value is closely tied to oil price cycles, as increased revenues from oil exports contribute to exchange rate stability, while declines lead to depreciation. This reinforces the argument that the Algerian economy's structural dependence on hydrocarbons plays a decisive role in determining exchange rate behavior.

The second hypothesis, which posits that external factors such as oil price volatility and international economic relations significantly shape exchange rate stability, is also validated. The analysis highlights how global oil price

fluctuations and external economic shocks, such as financial crises, have contributed to sharp movements in the dinar's exchange rate, demonstrating the economy's exposure to external vulnerabilities.

Furthermore, the third hypothesis, which suggests that Algeria's monetary policies (including adjustments to foreign exchange reserves and external financing strategies) are key determinants of exchange rate behavior, is supported by the findings. In the medium term, inflation rates and monetary interventions such as interest rate cuts and adjustments to the partial floating policy have had noticeable effects, reinforcing the need for effective monetary policy management to ensure currency stability. The role of monetary authorities in regulating exchange rate movements is particularly evident during periods of inflation, where interventions have mitigated excessive volatility.

Lastly, the hypothesis that government actions, such as devaluation or exchange rate liberalization, have directly influenced economic growth is confirmed. The short-term fluctuations in the exchange rate, often driven by speculation in the parallel market or global economic shocks, demonstrate the immediate effects of government interventions. Policies such as devaluation have been used as tools to address economic imbalances, but their long-term effectiveness depends on broader structural reforms.

To enhance the stability of the dinar and reduce its volatility, a comprehensive economic diversification strategy is essential. Strengthening non-oil productive sectors and encouraging investment in industry and agriculture would help reduce dependence on hydrocarbon revenues. Additionally, reinforcing the role of the central bank in managing monetary policy more efficiently can curb inflationary pressures and speculative activities. Stricter regulatory mechanisms on the parallel market, coupled with a well-calibrated flexible exchange rate policy, would further enhance exchange rate stability.

Ultimately, achieving sustainable currency stability requires deep structural reforms that go beyond short-term interventions. Diversifying national income sources, ensuring fiscal sustainability, and enhancing the regulatory capacity of monetary institutions are crucial steps toward mitigating external vulnerabilities and fostering a more resilient Algerian economy in the face of global economic shifts.

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