# ANALYSIS OF THE OIL PRICE VOLATILITY AND THEIR IMPACT ON INTERNAL DEBT VARIABLES IN IRAQ ECONOMY: WAVELET ANALYSIS TECHNIQUE

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**Abstract**

The Iraqi economy is a rentier economy; it depends heavily on crude oil revenues to finance the federal general budget. Hence, when any volatility in crude oil prices occurs, it will directly affect public revenues, so the fiscal policy goes to exceptional resources to finance the budget, including the internal public debt. Based on the pertinent conversations, this paper aims to study the impact of volatility oil prices on internal public debt by applying (ICSS) and the wavelet approach on the monthly dataset covering the period between 2004 and 2021. we found many breakpoints in the time series; it was the same as an increase in the proportion of the internal public debt and debt returns and debt growth rate at a significant level of 5%. And then, we found that the positive impact between the volatility oil prices on internal public debt variables is identified by considerable alterations throughout time during the sample period. Therefore, the most important requirements for economic stability are to diversify the sources of public revenue and reduce dependence on crude oil as a major resource for the public budget to avoid any shocks in global oil prices.

**keywords**: Volatility oil prices; Internal public debt; ICSS; wavelet approach

**JEL classification**: C10, C51, E39, H60

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## 1. INTRODUCTION

The volatility in the global oil market has resulted in a deterioration in oil revenues, which had a significant impact on the decline in the economic activity of oil-exporting countries, including Iraq. The oil resource represents the main nerve in Iraq. It depends on estimating its revenue, implementing its expenditure this year, and investing in the revenues derived from crude oil export to global markets. Therefore, any volatility in oil prices globally will directly impact the Iraqi economy. This is due to the decline in the economy's ability to implement plans and correct macroeconomic policies (Ali et al, 2019).

The main contribution to this paper is modeling the impact of oil price volatility on internal public debt variables, and this paper aims to review and analyze the fluctuation of crude oil prices on an international market and study their impact on the internal public debt in the Iraqi economy as a source of financing the federal budget deficit.

Therefore, the research hypothesizes a one-sided relationship between volatility oil prices that affect a positive direction in this relationship. When planning, the federal public budget in Iraq depended on crude oil revenues. According to reports of the Central Bank of Iraq, it constitutes the largest part of public revenues, amounting to 93% (CBI, 2015, 2019), and a large part of the GDP, up to 45%. So, therefore, any shock in crude oil prices in the global market, negatively or positively, is directly reflected in the sources of financing for the federal public budget, and that's the problem that we're trying to address in this paper.

To define key terms used in this paper, their definitions must be identified; Firstly, to know the concept of oil price volatility, it is necessary to know its primary causes; if those interested in oil prices see that speculation is responsible for the rapid increases in its prices, and on this basis, the rapid decline must be explained in the same way (Al-Tamimi et al, 2019). Therefore, the price of crude oil is defined as the value of the oil commodity expressed in monetary units at a specific and announced time and place and the monetary value of a barrel of crude oil in the American scale per barrel (Lefta et al, 2020).

Crude oil prices are subject to continuous volatility as a result of the nature of the international oil market, which is characterized by dynamism and instability, which is reflected in oil prices and made them unstable and subject to continuous volatility until it became a worrying phenomenon at the global level since the early seventies of the last century and is continuing until now (Faraj, 2020). This volatility in crude oil prices impacts the overall policy of the rentier-producing countries, which depend on crude oil as the leading resource to finance their expenditures, or the largest part of it, at least. One of the most important variables influenced by the volatility of crude oil is the internal public debt (AlFatlawy et al, 2021).

Decision-makers resort to exceptional sources to finance the general budget. These excellent sources are the internal public debt, that is, borrowing from local banks to indemnity the deficit in the general budget, The accumulation of internal

public debt is completely reflected in the economic situation of individuals, as it is considered a disguised part of the total income of individuals due to the increase in taxes to pay off the internal debt (Al-Tamimi & Abadi, 2019).

The internal public debt is the most critical source of financing the state's general budget deficit and one of the most important fiscal policy tools. It includes money that the state borrows from individuals and institutions to meet circumstances and achieve various goals due to the deficiency of other revenues to cover public expenditure (Oyeleke et al, 2018). From the above, the internal public debt can be defined as the total loans that the state obtains from natural or legal persons in its territory, regardless of their nationality, whether they are citizens or foreigners (Samuelson et al, 2005).

Therefore, the purpose of this paper is to analyse the impact of global oil price fluctuations on domestic public debt and to find out the ability of economic policymakers to make the right decision to cover the federal public budget deficit when there is an oil price breakdown on the world market, regardless of the causes of the breakdown.

Furthermore, the methodological discussion is still ongoing, and various research techniques have been applied to study the relation between oil price volatility and economic variables. Most studies use models of econometric with parameters. In this study, has been used the (Iterated Cumulative Sum of Squares algorithm) (ICSS), and a creative wavelet method to study and parallel the impact of oil prices volatility and internal public debt in Iraq's economy from 2004 to 2021.

The rest of the study is structured as follows. In section 2 the literature review is presented. Section 3 explains the empirical approach. The data used and their statistical characteristics across various time scales are presented in section 4. Section 5 provides the empirical results and their analysis. Section 6 concludes.

## 2. LITERATURE REVIEW

The Iraqi economy differs from the surrounding economies due to the rentier economy, its different characteristics, and the changes that occurred over the past 20 years; actually, little is present quantitative research on the impact of volatility oil prices on the internal public debt variables except for studying (Alfatlawy and al Shukri, 2021). Still, some research studied the relationship between volatility oil prices on other fiscal and macroeconomics variables.

Idris (2019) examined the Impact of Oil Price Fluctuation on Fiscal Policy in the Algerian Economy for the period between 1980 to 2014, using a Vector Auto Regression (VAR) approach, concluded that the oil prices shocks were the major reason for shocks in fiscal policy variables as expenditure and public revenue.

Al-Tamimi and Abadi (2019) checked the effect of volatility oil prices on public revenues, and they are taking a sample from 2003 until 2015. The research adopts the descriptive, theoretical method researchers recommend diversifying the

sources of revenue in the Iraqi economy to avoid the imbalances that occur due to fluctuations in oil prices in the global market.

Luaaiby et al. (2019) Consider the fluctuating oil earnings in Iraq from 2005 to 2015 while analyzing the sustainability of the public debt. The fluctuation of oil income and its impact on the public debt were taken into account in this analysis. Financial and economic indicators that indicate the risk of debt, as well as measures of debt sustainability, can be used to study this. Clarifying public debt's trajectory and local and international management were the study's main objectives. The connection between Iraq's rental economy and the danger of public debt was emphasized in this study. It is crucial to study ways to create a fund to maintain the budget deficit while working on high oil prices. As a result, there will be less danger in the future from utilizing public debt to close the budget deficit. As a result, the level of sustainable debt will remain the same.

Qasabi et al. (2020) analyze the relation between volatility oil prices and public expenditure in Algeria, using ARDL Approach from 2000-2018. The study complete that there is a long-term equilibrium relationship between oil prices and public expenditure; this relationship is progressive and significant in the long term.

AlFatlawy and Al Shukri (2021) studied volatility oil prices and their impact on the sustainability of public debt in Iraq, and they used data from 2000 to 2019 and Autoregressive Distributed Lag Estimates (ARDL). They found that oil price volatility has a positive and significant relationship with the public debt index, meaning that the increase in volatility leads to decisions regarding an increase in public debt to fill the shortage in resources.

From the previous studies, it is clear that the relationship of volatility oil prices and fiscal policy variables is very important. Different studies have examined this relationship but the extent to which effect on internal public debt variables is not explained by many researchers. This study will make an attempt to check effect between crude oil prices and internal public debt by using (ICSS) and wavelet (WTC) methodology.

## 3. METHODOLOGY

### 3.1. STRUCTURAL BREAKS IN VARIANCE

We use Analysis of the fluctuation specifications of "heterogeneity" to find structural breakpoints of the cluster center series by using "iterated cumulative sums of squares" (ICSS) of Inclan and Tiao (1994) to understand the temporal variation patterns of heterogeneity. Because it's crucial to identify and evaluate numerous structural breakpoints in volatility, because of the peculiarity of the economy and the period of our study, the time period when the relation between the volatility oil prices and internal public debt might be affected by possible shifts in the (unconditional variance) (Belhassine et al, 2021). The algorithm focuses on detecting the occurrence of changes in variance in time series due to a sudden shock that changes the variance until a next shock. The method assumes stationary variance of a time series over an

initial period of time until disturbed by an exogenous shock, thus resulting in a sudden change in variance (Inclan et al, 1994). Inclan and Tiao (1994) proposed to use the statistic given by (Inclan & Tiao, 1994):

$$IT = \sup_{k} \left| \sqrt{T/2} D_k \right| \tag{1}$$

Where $D_k = \frac{C_k}{C_T} - \frac{k}{T}$

And $C_k = \sum_{t=1}^{k} \varepsilon_t^2, k = 1, \dots, T$ is the cumulative sum of squares of $\varepsilon_t$. the assumption that $\varepsilon_t$ are a zero-mean, normally, identically, and independently distributed random variables, $\varepsilon_t \sim iidN(0, \sigma^2)$, the asymptotic distribution of the test is given by:

$$IT \Rightarrow \sup_{r} |W^*(r)| \tag{2}$$

where $W^*(r) \equiv W(r) - rW(1)$ is a Brownian Bridge, $W(r)$ is a standard Brownian motion and ⇒ stands for weak convergence of the associated probability measures.

### 3.2. THE WAVELETS APPROACH

The Fourier Transform (FT) is a useful method for observing the frequency components of the signal. But, when we theorize the FT over the entire time axis, we are unable to clearly monitor a certain frequency (Bilgili, 2020). To get around this restriction, the wavelet analysis has been proposed. Wavelet calculation uses a mathematical impersonation of the (FT) through its new feature of calibration. Wavelet analysis provides a characteristic since it has elasticity in using different (non-stationary) signals. Wavelets have the characteristic of being localized over time scale, because they are structured over discrete time periods and move uniformly throughout time (James B Ramsey, 2014). This analysis takes into both time and scale domains with each other. Because of this, ripples can discretize data into different frequency components. (Bilgili, 2020). A wavelet follows an oscillating, complex or real function $\gamma(t) \in L^2(\mathbb{R})$. The factor $_{(s,\ell)}(t)$ used to create the wavelet family is called the "mother wavelet", and it can be written as below:

$$\partial_{(s,\ell)}(t) = |s|^{-1/2}\, \partial(s/(t-\ell))^{-1} \qquad s, l \in \mathbb{R} \text{ and } s \neq 0 \tag{3}$$

where the term $|s|^{-1/2}$ defined as the arrangement factor. The mother wavelet $\mathfrak{Z}$ contains scaled $(s)$ and located $(\ell)$ parameters. The factor controls the wavelet's width in addition to the frequency domain position of the wavelet. The wavelet's time domain position is controlled by the $(\ell)$ factor. So, CWT analysis the dataset into different saving periods and provides the actual dynamics and co-movements of the variables. This study applies CWT to find the relation between volatility of oil

prices and internal public debt. CWT's key advantage is that it manages of the heterogeneity by considering the countenance from both the time and frequency domain, see details (Aguiar-Conraria et al, 2010; Haque et al, 2017). To obtain the continuous wavelet transform $w_X(u,S)$, the mother wavelet $\mathfrak{X}$ is projected onto the examined time series $x(t) \in L^2(\mathbb{R})$, so that:

$$W_x(u,s) = \int_{-\infty}^{+\infty} x(t) \frac{1}{\sqrt{s}} \psi\left(\frac{t-u}{s}\right) dt \tag{4}$$

Eq. (4), $u$ is the wavelet location parameter, and $S$ is the wavelet scale parameter. The squared wavelet coherence coefficient of two time series $x$ and $y$ is defined as follows:

$$R^2(u,s) = \frac{\left|S\left(s^{-1}W_{xy}(u,s)\right)\right|^2}{S(s^{-1}|W_x(u,s)|^2)S\left(s^{-1}\left|W_y(u,s)\right|^2\right)} \tag{5}$$

where $S$ is a smoothing operator $W_x(u,s)$ to the CWT of the time series $x, W_y(u,s)$ indicates the CWT of the time series $x$, and $W_{xy}(u,s)$ is a cross wavelet transform of the two time-series $x$ and $y$. The squared wavelet coherence coefficient ranges from 0 to 1 (see details (Gençay, 2001; Madaleno et al, 2012)).

## 4. DATA

Our data collection includes monthly oil prices and internal public debt. It ranges from January 2004 to December 2021. For Iraq country, our sample. and use the monthly price data of "West Texas Intermediate" (WTI)-Historical data- crude oil as a proxy for world oil price levels.

We created time series graphs of volatility oil prices, internal public debt, returns debt, and public debt growth rate, to help with the descriptive analysis of the data. Fig.1 shows the dynamics of the time series graphs, and the upper figure shows crude oil prices in international markets, and the lower figure shows the internal public debt. We note that a rise follows any fall in oil prices in the quantity of internal public debt. This is because the fiscal policy seeks to reduce the deficit in the public budget through internal borrowing, and the middle figure shows price volatility Oil. With a simulation model between the parts of the figure, the size of the initial impact of the fall in crude oil prices becomes evident.

The figure can also show the path of public debt returns as well as the growth rate of public debt, as the effect resulting from the volatility of oil prices is a little late due to the gradual fall in international oil prices, as well as the public debt and its estimates require government intervention to put the appropriate decision through fiscal policy, so notes the delay in responding to the effects of oil price volatility on the time series.

***Table 1 Descriptive Statistics for the time series***

| variables | volatility oil prices | internal public debt | returns debt | debt growth rate |
|---|---|---|---|---|
| code | VOP | PDEBT | REDEBT | GDEBT |
| Source | IMF* | CBI** | CBI | CBI |
| Mean | 47.08560 | 16.39532 | 1.119628 | 482.6325 |
| Median | 29.35526 | 15.89463 | -0.000218 | -0.002617 |
| Maximum | 631.0832 | 18.06275 | 52.10908 | 51861.55 |
| Minimum | 5.831878 | 15.25192 | -35.37781 | -98.56691 |
| Std. Dev. | 60.27168 | 0.966338 | 8.015933 | 3959.782 |
| Skewness | 6.772929 | 0.459071 | 2.671925 | 11.07101 |
| Kurtosis | 59.18391 | 1.492543 | 20.70312 | 136.8362 |
| Jarque-Bera | 29921.93 | 28.03870 | 3063.366 | 164854.8 |
| Probability | 0.000000 | 0.000001 | 0.000000 | 0.000000 |

***** International Monetary Fund
******Iraq Central Bank

Table 1 shown the statistical characteristics of volatility oil prices, internal public debt, returns debt and public debt growth rate, Indications series at each wavelet detail. The results show that the wavelet details' standard deviations oscillate but increase across scales. Moreover, all variables indicating The Jarque-Bera (J-B) test statistic rejects normality at a high significance level.

We checked the unit root of the variables shown in Table 2 before beginning the inquiry by using the wavelet technique. Two unit root tests have been used: The Augmented Dickey-Fuller and the Phillips–Perron test. As described in Appendix Table 2, all variables become stationary in level -Except for the internal public debt variable in the first difference became stationary -The volatility of oil prices, the returns debt and public debt growth rate the existence of unit root in level. However, in the situation of the internal public debt, this variable is stationary in the first difference because it follows the structural changes in the Iraqi economy. We remember that one of the main advantages of wavelet analysis is (flexibility) to resolve data series abnormalities, nonstationary, and changing frequencies all time (Gallegati, 2012; James B Ramsey, 1999).

The descriptive correlations between the variables will still be examined, calculating the Pearson correlation, and reporting the coefficients with their p-value. Table 3 shows that the (VOP) is positively correlated weak with the (REDEBT) and (GDEBT) but negatively correlated weak with the (DEBT), It could indicate how the demand shock affected the (DEBT). But it is belatedly due to the nature of the decision taken by the fiscal policy to finance the deficit in the federal general budget.

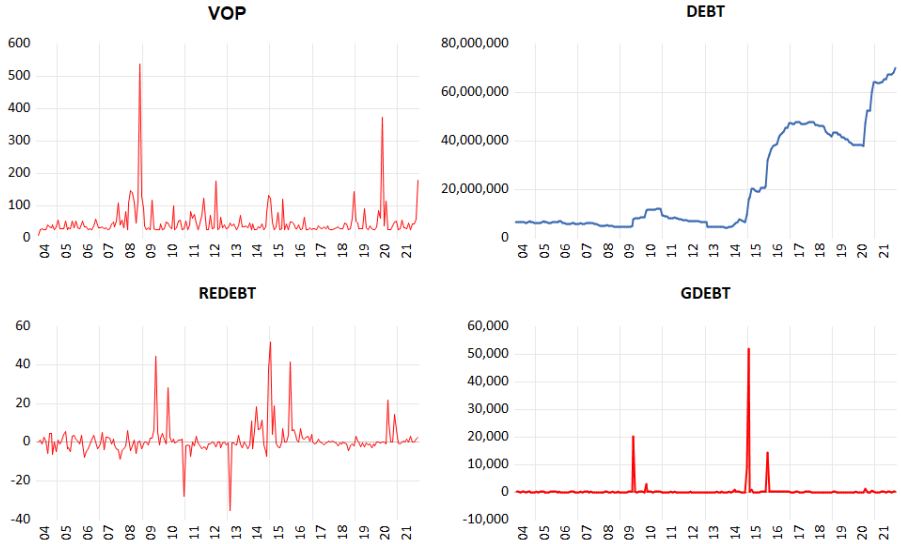


***Figure 1. Monthly data of variables***

Finally, this correlation is not significant. Due to the numerous breaks in the time series, there are no meaningful correlations between the variables indicating the internal public debt in the economy of Iraq. The ICSS algorithm will be used to test and validate the breakpoint, and then the wavelet approach will examine variables in the next section.

***Table 2. Pearson correlations between research data***

| Correlation<br>Probability | VOP | DEBT | REDEBT | GDEBT |
|---|---|---|---|---|
| VOP | 1.000000<br>----- | | | |
| DEBT | -0.054744<br>0.4245 | 1.000000<br>----- | | |
| REDEBT | 0.336833<br>0.0212 | 0.066403<br>0.3325 | 1.000000<br>----- | |
| GDEBT | 0.395610<br>0.0224 | -0.027549<br>0.6879 | 0.678998<br>0.0000 | 1.000000<br>----- |

*Source (Calculated by R studio)*

# 5. RESULTS AND DISCUSSION

## 5.1. STRUCTURAL BREAKS IN VARIANCE

We use the Iterated Cumulative Sums of Squares (ICSS) algorithm in order to determine the points where the variance undergoes regime change, in addition to this study, in order to show in which periods, the high and low volatility regimes are experienced. (The ICSS algorithm can be analyzed in the Win RATS Estima program). This method detects breaks that occur due to sudden shocks that may cause a change in variance in any time series, as shown in Table 4. According to the ICSS test results of the data between the first month of 2004 to the latest month of 2021, which is the review period, multi breaks occurred in the indexes variance in this period. Table 4 show the discovered structural break dates for the (VOP), (DEBT), (REDBT), and (GDEBT) series being investigated using the ICSS algorithm at various time scales. It reveals a striking variety in the number of structural breaks throughout time and at various time scales for the same variable.

***Table 4. (ICSS) algorithm results***

| Series | Shift Points (Fracture) | Time Period | Standard Deviation |
|---|---|---|---|
| VOP | 5 | 2008:05 | 0.002884 |
| | | 2008:12 | 0.021290 |
| | | 2014:06 | 0.004190 |
| | | 2020:01 | 0.004604 |
| | | 2020:04 | 0.010176 |
| DEBT | 6 | 2009:06 | 0.003227 |
| | | 2010:03 | 0.019034 |
| | | 2014:11 | 0.008117 |
| | | 2015:12 | 0.010639 |
| | | 2020:06 | 0.007093 |
| | | 2020:11 | 0.007241 |
| REDEBT | 6 | 2009:06 | 0.004817 |
| | | 2010:03 | 0.009377 |
| | | 2014:11 | 0.005486 |
| | | 2015:12 | 0.004112 |
| | | 2020:06 | 0.002847 |
| | | 2020:11 | 0.004749 |
| GDEBT | 6 | 2009:07 | 0.009331 |
| | | 2009:08 | 0.008205 |
| | | 2014:11 | 0.006751 |
| | | 2015:01 | 0.015369 |
| | | 2015:11 | 0.001172 |
| | | 2015:12 | 0.002663 |

***Note: Table 4 presents the (ICSS) algorithm using significance level 0.05.***

*Source (Calculated by Winrate)*

Furthermore, all indexes at all time scales show at smaller five and at generality six break points in their difference during the entire sample period; these breakpoints are caused by the decrease in oil prices in global markets, either because of the financial crisis as in 2008 or because of the decline in demand for energy as at the end of 2020 due to the Covid-19 pandemic, in addition to the fact that there are structural interruptions that did not appear during the research period and for which no break data are discovered. These specified break data can be concerning to either prime global or country-particular proceedings like the war on terror in 2014. The graphical representation of the size of the breaks in the variance is given in Fig 2.

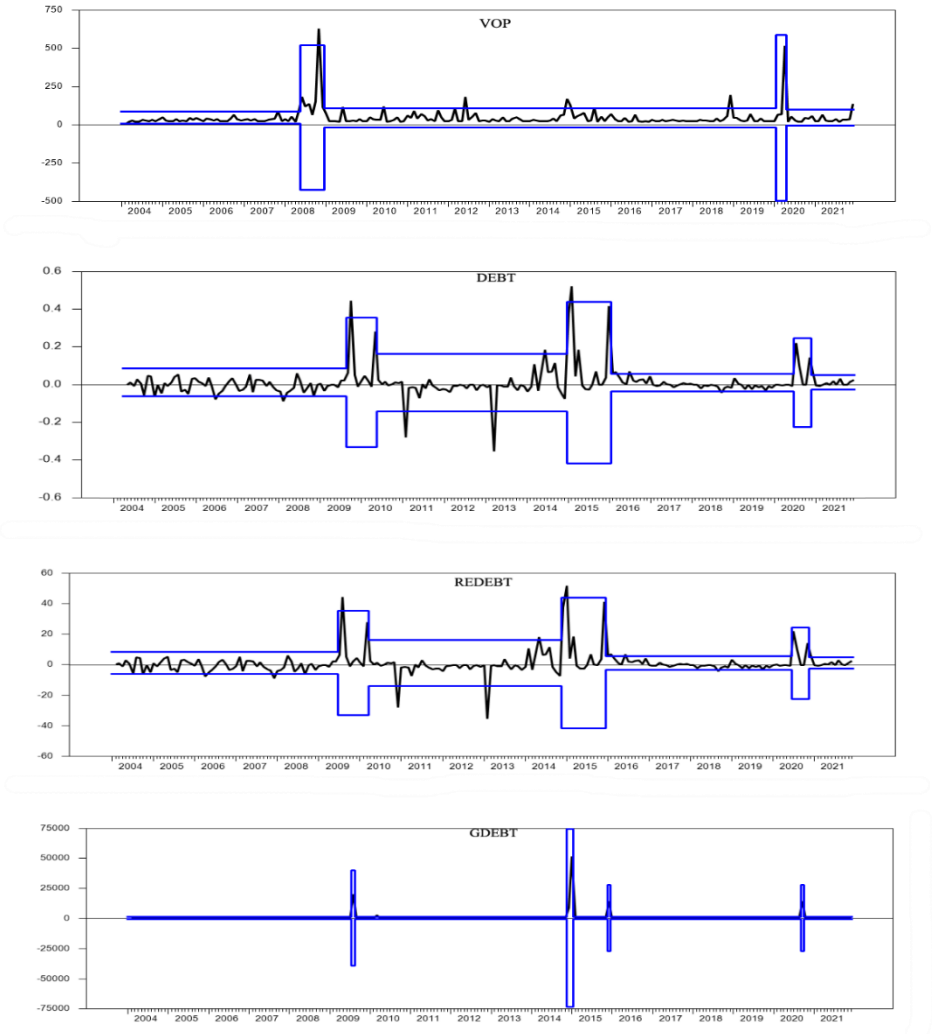


***Figure 2.*** *Variance Breakout Periods in time Series*

## 5.2. THE CONTINUOUS WAVELET TRANSFORMS AND WAVELET COHERENCE ANALYSIS

The (ICSS) algorithm demonstrates the time series of oil price, internal public debt, debt returns, and debt growth rate all inhibit structural breaks (breakpoints). Which means the regression based econometric techniques will be suffered from statistical inference defeat (spurious relationship) while investigating the relationship between oil price volatility and internal public debt. Therefore, the wavelet analysis is introduced. Because the main quality of wavelet analysis over econometric time series modeling methods is its ability to grab slow and continual co-movements, allowing for a more nuanced realization of the interdependence between two time series (in the time and frequency domains) (Belhassine & Karamti, 2021).

In the first analysis, we apply the continuous wavelet transform between the VOP and internal public debt indexes, The [CWT] in Fig. 3, graphs for all indices are displayed. The [CWT] describe how each index changes over time and across different frequency ranges. As the figure, the horizontal axis shows the time component; The period is shown on the horizontal "axis", from January 2004 to December 2021, while the vertical axis display the frequency component. The frequency component extends from the (0-scale) to the more than (64-scale). In each graph, the areas having a significance level of 5% are shown by the black contours (Managi et al, 2022).

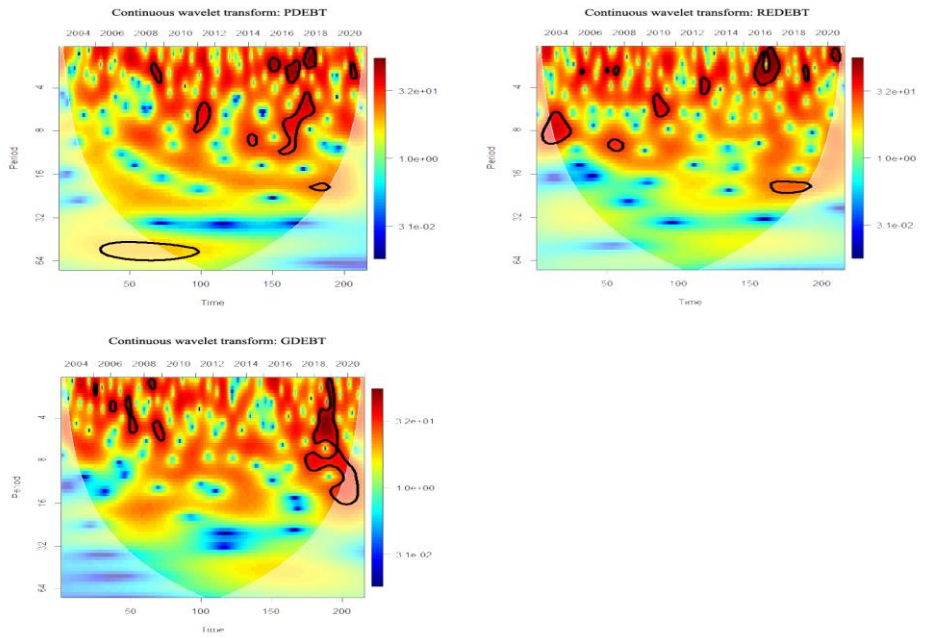


***Figure 3.*** *Continuous wavelet transform (CWT) plots for VOP and internal public debt indexes*

When we examine the price plots of the volatility of the oil prices VOP, PDEBT, REDEBT, and GDEBT in more detail, we can plainly observe that the [CWT] plots display different areas of high short- and long-term volatility (frequency bands of 0–64) during the research period.

An intriguing interaction is indicated by this frequency range with the global financial crisis in 2008 and decrease crude oil price after 2013, and during the war on terror between 2014 and 2015, with the (COVID-19) pandemic's quick spread concerning the world during (2020 and 2021). The results, as shown in Fig 3, indicate to the response of the internal public debt (PDEBT) to the change in world oil prices is not direct because the direct impact is on the reduction of public revenues through which the public budget is financed, and this leads to a reduction of funding sources. Hence, the fiscal policy head to finance the deficit through the internal public debt, the impact relation between VOP and PDEBT is more pronounced at the mid and end of the sample period, indicating the persistence of impact spillover transmission between the VOP and PDEBT. Where on the [CWT] plots, the black outline shows the (5%) significance level, the warmer red color identify to the area with higher co-movements, while the cooler blue color shown the area with low (co-movements).

Further, it is worth noting that the impact relationship between the VOP and REDEBT and GDEBT it's the same impact for PDEBT but its lags because the fiscal policy decisions are made annually. Finally, the CWT shows that the volatility of oil prices significantly impacted all indexes.

The second analysis, we apply the Wavelet coherency [WTC] plots between VOP and internal public debt. Arrows point in the direction of causal and interdependent relations (Jiang et al, 2020; Managi et al, 2022; Pal et al, 2019; Tiwari, 2013; Torrence et al, 1999; Yang et al, 2017). For Interpretation the Fig 4. We need to know what arrows mean, "If the arrows point to the right, this should indicate that the two series are positively correlated. On the other hand, when the arrows are turned to the left, it should indicate that the two indexes are negatively correlated". "Arrows facing up-right and down-left (↗↙) mean that the first variable drives the second, while arrows facing down-right and up-left (↘↖) indicate that there is a countercyclical effect where the second variable drives the first. In contrast, the right up (↑) and down (↓) arrows imply that the variable is leading and lagging, respectively" (Managi et al, 2022).

Moreover, in explanation the Wavelet coherency dynamics, which are found with the "arrow" direction in each plot, the wavelet coherence interpretation is (3-dimensional). Firstly, the time dimension is measured along the x-axis. Secondly, the y-axis is where the frequency dimension is measured, and the frequency scales range from 0-scale (highest frequency) to 64-scale (lowest frequency). Thirdly, the color dimension is used to gauge how strongly the two series are coherent. The outlines in blue denote a weak correlation, the contours in green and yellow a moderate correlation, and the contours in red a significant correlation (Phiri et al, 2021). Within each of the Fig 4 arrow denotes, The VOP and the PDEBT two shows

especially significant co-movement through the sample period, but the large area of the highest degree of co-movement after 2013 between scale 0-16 and 2014, 2016 is the same case after that is in the (COVID-19) health crisis era. This demonstrates a significant dependency on both the short- and long-term (0-64 months) monthly frequency bands at the start, middle, and end of the sample period. The faint white lines encirclement the (arrows) indicate the 5% significance level, whereas curved "inverted U-shaped" line represents the cone of influence. We identify most frequently Arrows facing up-right and down-left (↗↙), particularly between 2016 to 2021 because the global oil market has witnessed a lot of volatility, as mentioned above, in contrast, showed during the 2008 financial crisis the positive relationship between VOP and PDEBT that indicate of the sample period on both the long-term (16–64 months) monthly frequency bands at level 5%. The economic explanation for this case is the fiscal and monetary policy (the Central Bank of Iraq) resorted to internal borrowing to fill the shortfall in crude oil revenues, finance operational and investment public expenditure, and increase the requirements for reconstruction during that period (AlFatlawy & Al Shukri, 2021).

The VOP and the REDEBT the large area of highest degree of co-movement after 2013 to the COVID-19 pandemic between scale 0-16 except for the period between 2008-2009 We identify Arrows consideration up-right and down-left (↗↙), that meaning The VOP led REDBT in this period and between 2018 to 2021, when arrows are typically pointed straight up ( ↑ ) or straight down ( ↓ ), we cannot speak which of the series is leading the other particularly (8-16 month band between 2019 and 2021) at level 5%, which can be economic interpreted for this case is that debt returns are not directly related to fluctuations in oil prices, so there is a delay in affecting them, and it may take time while the government repays loans from local governmental and commercial banks, in addition to the fact that the general budget law is basically taken on an annual (Belhassine et al, 2021).

For the VOP and the GDEBT, we detect a few areas of high and co-movement between them through the sample period. The trend of the arrows pointing arrows are most of the time pointing straight-up (↑) or straight down (↓) except for the period between 2013-2016 (0–4-month band) because after any shocks in oil prices, will be a direct effect on the growth rate of the internal public debt, Because the government needs to finance its public expenditures.

Finally, We observed that several areas inside the white lines enclosing the arrows represent the 5-percent significance level (the cone of effect is inside the curved, inverted U-shaped line); this gives us an indication of the existence of an impact relationship between oil price fluctuations and internal public debt indexes, this is confirmed by the results of the analysis Wavelet coherency (WTC).

## 6. CONCLUSION

This paper gives to the literature on the relation between volatility oil prices and internal public debt variables by analyzing the volatility impact, transmission, and correlation between them, In addition, the effectiveness of the fiscal policy in the face of the lack of resources caused by the lack of liquidity due to the decline in oil prices in global markets, which is the primary resource for financing the expenditures of the federal public budget in Iraq economy, where was the present research aimed to examine the impact and try to avoid this impact in the long and short term.

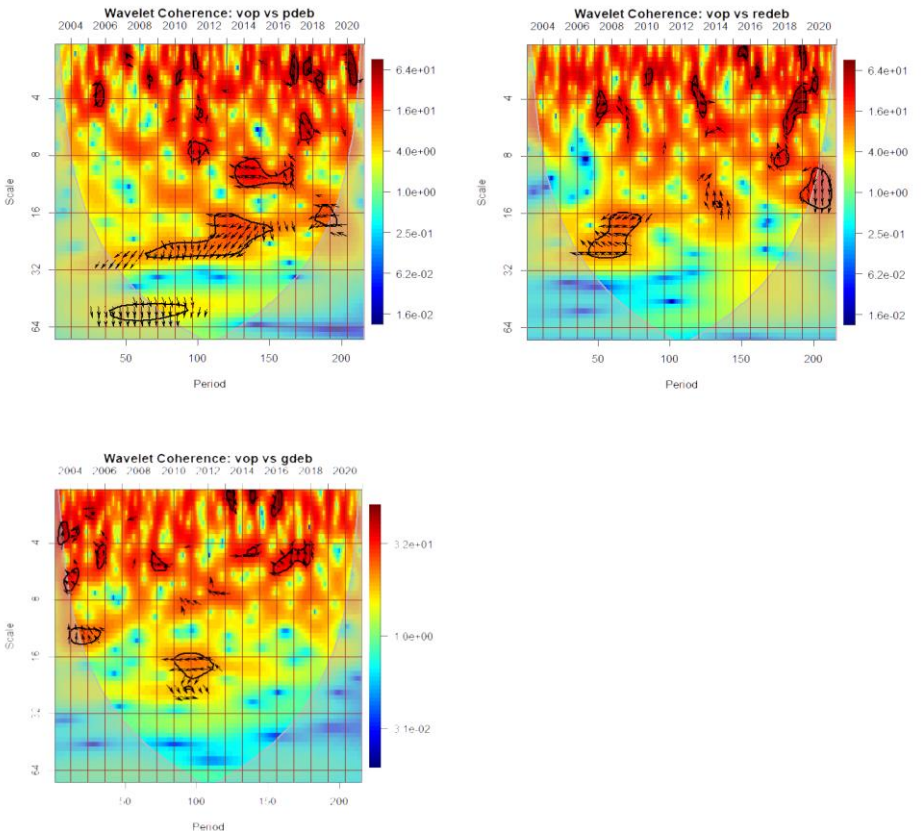


***Figure 4.*** *Wavelet coherence between VOP index and internal public debt index*

We used the (ICSS) algorithm to examine structural breaks. In time series and used "continuous wavelet transformation and wavelet coherence approach" to investigate impact of volatility oil prices on internal public debt and their effects on the associations between them. And it is important to mention that the outcomes of the (ICSS) algorithm are in line with the continuous wavelet transformation and wavelet coherence approach in determining the structural breaks. During the study period, due to the volatility of international oil prices. The Iraqi economy is a

unilateral (Economic Rent) on the revenue side, as crude oil revenues represent (90-93%) of the total public revenues. Therefore, volatility in world oil prices is reflected (negatively) on the total revenues. When a shortage of funding sources occurs, the financial policy resorts to internal public debt ( government and private banks), by increasing the volume of the internal public debt to fill the shortfall in funding sources,

In contrast, there will be an increase in the volume of the internal public debt with any (negative) shock to oil prices in global markets. Our findings sight that the volatility oil prices imposed the effect between the most couple variables (VOP-PDEBT), (VOP-REDEBT), and (VOP-GDEBT). This is expected because of the positive relationship between the variables, the approach used to confirm this relationship, and the closest example is the COVID-19 pandemic.

Thus, the macroeconomic policy requires strong regulatory actions and alternative survival techniques to maintain the economy's stability. Nevertheless, Iraq policymakers may impose favorable macroeconomic policies to survive the crisis as a volatility oil prices. The most important of these requirements is to diversify the sources of public revenue and reduce dependence on crude oil as a major resource for the public budget.

In addition, future empirical studies can also be conducted on this subject by examining an analysis based on the effects of the volatility oil prices in several sectors, for instance, Industry, agriculture, and the financial sector, in order to develop them and increase their contribution to the gross domestic product in the Iraqi economy.

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## Appendix

***Table 3. Unit root tests***

| **ADF test** | | | | | |
|---|---|---|---|---|---|
| **At Level** | | | | | |
| | | VOP | DEBT | REDEBT | GDEBT |

| | | | | | |
|---|---|---|---|---|---|
| With Constant | t-Statistic | -11.6889 | 1.2140 | -11.0771 | -12.7550 |
| | ***Prob.*** | ***0.0000*** | ***0.9982*** | ***0.0000*** | ***0.0000*** |
| | | *** | n0 | *** | *** |
| With Constant & Trend | t-Statistic | -11.6614 | -1.0140 | -11.1280 | -12.7309 |
| | ***Prob.*** | ***0.0000*** | ***0.9388*** | ***0.0000*** | ***0.0000*** |
| | | *** | n0 | *** | *** |
| Without Constant & Trend | t-Statistic | -4.1273 | 2.3952 | -10.9332 | -12.6189 |
| | ***Prob.*** | ***0.0000*** | ***0.9962*** | ***0.0000*** | ***0.0000*** |
| | | *** | n0 | *** | *** |
| **At First Difference** | | | | | |
| | | d(VOP) | d(DEBT) | d(REDEBT) | d(GDEBT) |
| With Constant | t-Statistic | -11.9505 | -10.5171 | -11.0380 | -9.2637 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0000*** | ***0.0000*** |
| | | *** | *** | *** | *** |
| With Constant & Trend | t-Statistic | -11.9195 | -10.8058 | -11.0103 | -9.2424 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0000*** | ***0.0000*** |
| | | *** | *** | *** | *** |
| Without Constant & Trend | t-Statistic | -11.9786 | -10.2066 | -11.0654 | -9.2877 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0000*** | ***0.0000*** |
| | | *** | *** | *** | *** |
| **PP test** | | | | | |
| **At Level** | | | | | |
| | | VOP | DEBT | REDEBT | GDEBT |
| With Constant | t-Statistic | -11.8224 | 1.0245 | -11.1461 | -12.7474 |
| | ***Prob.*** | ***0.0000*** | ***0.9968*** | ***0.0000*** | ***0.0000*** |
| | | *** | n0 | *** | *** |
| With Constant & Trend | t-Statistic | -11.7964 | -1.1508 | -11.1860 | -12.7230 |
| | ***Prob.*** | ***0.0000*** | ***0.9169*** | ***0.0000*** | ***0.0000*** |
| | | *** | n0 | *** | *** |
| Without Constant & Trend | t-Statistic | -9.1349 | 2.2232 | -11.0730 | -12.6189 |
| | ***Prob.*** | ***0.0000*** | ***0.9939*** | ***0.0000*** | ***0.0000*** |
| | | *** | n0 | *** | *** |
| | | | | | |
| **At First Difference** | | | | | |
| | | d(VOP) | d(DEBT) | d(REDEBT) | d(GDEBT) |
| With Constant | t-Statistic | -118.0820 | -11.0315 | -82.8637 | -174.4962 |

| | | | | | |
|---|---|---|---|---|---|
| | ***Prob.*** | ***0.0001*** | ***0.0000*** | ***0.0001*** | ***0.0001*** |
| | | *** | *** | *** | *** |
| With Constant & Trend | t-Statistic | -114.7636 | -11.1335 | -82.4606 | -176.8320 |
| | ***Prob.*** | ***0.0001*** | ***0.0000*** | ***0.0001*** | ***0.0001*** |
| | | *** | *** | *** | *** |
| Without Constant & Trend | t-Statistic | -110.4702 | -10.8628 | -83.0627 | -175.0660 |
| | ***Prob.*** | ***0.0001*** | ***0.0000*** | ***0.0001*** | ***0.0001*** |
| | | *** | *** | *** | *** |

***Notes: *Significance at the 10% level. **Significance at the 5% level. ***Significance at the 1% level.***