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How Safe Are the Safe Haven Assets? Insights From a Novel Cross-Frequency Analysis

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This study examines the safe haven properties of Bitcoin and Gold in relation to crude oil price fluctuations using a method that incorporates cross-frequency information spillover. The findings indicate that both Bitcoin and Gold exhibit cross-frequency safe haven properties. The results suggest that gold is a more effective safe haven asset. The identification of cross-frequency safe haven properties highlights the importance of developing diverse portfolio management strategies while considering potential cross-frequency information spillover.

I. Introduction

In this paper, we study the potential safe-haven properties of Bitcoin and Gold against crude oil return fluctuations while considering the possibility of cross-frequency information flow across quantiles. Towards this, we modify the wavelet quantile correlation method of Kumar and Padakandla (2022). The global crude oil market has recently faced significant turmoil, notably due to the COVID-19 pandemic and the Russia-Ukraine war, drastically altering financial dynamics and investor behaviour (Corbet et al., 2020). During the COVID-19 pandemic, the US West Texas Intermediate (WTI) price fell to an unprecedented low of -\$37 per barrel (Huang et al., 2022; Liu & Lee, 2022). However, following the onset of the Russia-Ukraine conflict, the market experienced a sharp recovery, with prices surging by 8% to reach \$123.70 per barrel, the highest level since 2012 (Mohamad, 2022). Under such volatile market conditions, identifying the right safe-haven assets has become a serious issue.

A safe haven asset is one that either retains or increases its value during times of market turbulence. Inclusion of safe haven assets in an investment portfolio is crucial, as it helps mitigate risks during market turmoil. This area of research has evolved significantly, from the seminal papers by Baur and Lucey (2010) and Baur and McDermott (2010) to more recent analyses by Azimli (2024), and Ryan et al. (2024). Historically, gold has been widely recognized as a safe-haven asset and extensively studied for its role in extreme market conditions. While some research supports gold's effectiveness as a safe haven, particularly against

crude oil (Liu & Lee, 2022; Selmi et al., 2018), other studies show a positive correlation between gold and oil during economic turmoil, challenging gold's reliability as a safe haven in all scenarios (Mo et al., 2018). In this backdrop, there was increased interest in exploring alternative safe-haven assets such as Cryptocurrencies, especially Bitcoin. While some studies (Bouri et al., 2017; Stensås et al., 2019) identify Bitcoin as a safe haven for stocks and emerging markets, other research (Shahzad et al., 2019; Smales, 2019) questions its reliability as a consistent safe haven.

In the backdrop of the COVID-19 pandemic and the Russia-Ukraine crisis, research has examined Bitcoin's role during periods of financial turmoil and economic uncertainty. In the context of the 2020 crude oil market crash, Dutta et al. (2020) found that gold outperformed Bitcoin as a safe haven, with Bitcoin functioning more as a diversifier. Wen et al. (2022) further found that while Gold and Bitcoin exhibited similar safe haven characteristics before the pandemic, gold proved to be a better hedge during the crisis, mainly as the pandemic spread. However, Ren et al. (2022) and Tarchella et al. (2024), suggest a contrasting view, proposing that Bitcoin's safe-haven properties strengthened as the pandemic intensified, while gold's role weakened, with gold acting more as a diversifier. This evidence underscores the ongoing debate over Bitcoin's efficacy as a safe-haven asset, especially when compared to traditional assets like gold.

Among the methods to empirically verify the safe haven property, the commonly used method is the GARCH-based regression model by Ratner and Chiu (2013), extending Baur and Lucey's seminal research (2010). However, this

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approach is limited in its ability to capture the time-frequency dynamics of an asset's safe-haven properties. To address this, methods such as the wavelet quantile-in-quantile regression (Bouri et al., 2017) and the wavelet quantile correlation method (Kumar & Padakandla, 2022) were proposed. These methods capture an asset's behaviour across different time horizons, providing a more nuanced understanding of its safe-haven properties. However, these models assume that information flow occurs only within corresponding frequencies, such as daily-to-daily or weekly-to-weekly interactions. While this assumption holds, there is no evidence to suggest a complete absence of cross-frequency information flow, such as weekly-to-monthly or monthly-to-daily interactions. Here, we test the possibility of cross-frequency information flow between assets.

To the best of our knowledge, this is the first study to analyze cross-frequency safe haven properties. Apart from this methodological advancement, the contribution of our article is threefold. First, we establish cross-frequency information flow between assets. Second, we confirm that gold remains a superior safe-haven instrument, even after accounting for all possible information spillovers. Finally, we identify cross-frequency investment strategies for investors, which are of practical importance and are the first of their kind.

The rest of the article is structured as follows. In section II, we briefly discuss the data and methodology. Section III details our results and discussion. In section IV, we offer our concluding remarks.

II. Data and Methodology

We utilize daily returns data for Bitcoin, Gold, WTI, and Brent spanning from January 1, 2019, to May 31, 2024. Data for WTI and Brent are sourced from the US Federal Reserve Economic Data (FRED) database. Bitcoin data is obtained from CoinMarketCap, while Gold data is sourced from the World Gold Council database.

In accordance with Li et al. (2015) and Kumar & Padakandla (2022), we define the wavelet quantile correlation (QC) between two assets, X and Y , as follows: Let $Q_{\tau,X}$ be the τ^{th} quantile of X and $Q_{\tau,Y}(X)$ be the τ^{th} quantile of Y conditional upon X . $Q_{\tau,Y}(X)$ is independent of X if and only if the random variables $I(Y - Q_{\tau,Y}) > 0$ and X are independent. Here $I(\cdot)$ is the indicator function. For $0 < \tau < 1$, the quantile covariance is defined as:

$$qcov_t(Y, X) = cov\{I(Y - Q_{\tau,Y}) > 0, x\} = E(\phi_\tau(Y - Q_{\tau,Y})(X - E(X))) \quad (1)$$

Here $\phi_\tau(w) = \tau - I(w < 0)$. Then, the quantile correlation is as follows:

$$qcor_t(X, Y) = \frac{qcov_t(Y, X)}{\sqrt{(var(\phi_\tau(Y - Q_{\tau,Y})) var(X))}} \quad (2)$$

We posit that investors exhibit diverse preferences across different timescales when selecting a hedge, safe haven, or diversifier asset. This preference can be understood by examining the dependence structure at varying timescales. To achieve this, we employ Wavelet Quantile Correlation (WQC).

First, we decompose the asset pairs using a maximal overlapping discrete wavelet transform (MODWT) on X and Y . Consider a signal $X[i]$ of length T where $T = 2^J$ for some integer J . Let $h_1[i]$ and $g_1[i]$ be the low-pass and the high-pass filter, defined by an orthogonal wavelet. First, $X[i]$ is convolved with $h_1[i]$ to obtain the approximation coefficients $a_1[i]$ and with $g_1[i]$ to obtain the detail coefficients $d_1[i]$. Here, $a_1[i]$ and $d_1[i]$ are of length N . Next, $a_1[i]$ is filtered using the same scheme, but with modified filters $h_2[i]$ and $g_2[i]$, obtained by dyadic up-sampling $h_1[i]$ and $g_1[i]$. This process is continued recursively. For $J = 1, 2, \dots, J$, where $J_0 \leq J$, we can calculate the approximate and detailed coefficients as:

$$a_{j+1}[i] = h_{j+1}[i] * a_j[i] = \sum_k h_{j+1}[i - k] a_j[i] \quad (3)$$

$$d_{j+1}[i] = g_{j+1}[i] * a_j[i] = \sum_k g_{j+1}[i - k] a_j[i] \quad (4)$$

$$\text{Where } h_{j+1}[i] = U(h_j[i]) \text{ and } g_{j+1}[i] = U(g_j[i]). \quad (5)$$

U is the up-sampling operator. After a J level decomposition to X and Y , Kumar and Padakandla (2022) apply QC to wavelet details $d_i[X]$ and $d_j[Y]$ of corresponding frequencies (i.e $i = j$) for all J , and estimate WQC for each level. The WQC for two-time series X and Y at a given level J and quantile τ is:

$$WQC_\tau(d_i[X], d_j[Y]) = \frac{qcov_\tau(d_j[Y], d_i[X])}{\sqrt{var(\phi_\tau(d_j[Y] - Q_{\tau,d_j[Y]})) var(d_i[X])}} \quad (6)$$

$$\text{where } i = 1, 2, \dots, J \text{ and } j = 1, 2, \dots, J$$

We slightly modify Equation (6) by estimating WQC for both $i = j$ and $i \neq j$ and define wavelet cross quantile correlation (WCQC henceforth). WCQC can be treated as a general version of WQC, where the tail dependence between all frequencies across different quantiles are modelled. WCQC reduces to WQC when $i = j$.

Following Kumar and Padakandla (2022), we use wavelet details for 2-4 days, 16-32 days, and 128-256 days, corresponding to a week, month, and year. We estimate WCQC for Week-Week, Week-Month, Week-Year, Month-Week, Month-Month, Month-Year, Year-Week, Year-Month, and Year-Year correlations. The conventional WQC only includes Week-Week, Month-Month, and Year-Year frequencies.

III. Results

The results are presented in Table 1. As our analysis focuses on the safe haven properties of Bitcoin and Gold in relation to crude oil fluctuations, we will confine our WCQC analysis to the 0.05th quantile. Detailed results can be provided upon request. According to Baur and Lucey (2010), for an asset to demonstrate safe haven properties, it should exhibit either zero or negative correlation during crisis periods. In the WCQC framework, extreme events are captured at the 0.05th quantile. Consequently, for an asset to qualify as a safe haven, its WCQC at the 0.05th quantile must be either negative or zero.

We present the results for each asset pair as reported in Table 1. For the Brent/Bitcoin pair, the wavelet coherence quantile correlation (WCQC) is positive across all corresponding scales (week-week, month-month, and year-year). However, a negative correlation is observed at two

Table 1. WCQC results

Combination	Brent/BTC	Brent/Gold	WTI/BTC	WTI/Gold
Month-Month	0.175	0.136	0.223	0.020
Month-Week	0.046	0.014	0.011	0.042
Month-Year	0.015	-0.013	0.009	-0.004
Week-Month	-0.004	-0.010	-0.044	0.054
Week-Week	0.036	0.007	0.070	0.009
Week-Year	-0.003	-0.012	0.000	-0.003
Year-Month	0.035	0.099	0.034	0.103
Year-Week	0.011	0.084	0.005	0.078
Year-Year	0.094	-0.219	0.073	-0.199

This table presents the results of the wavelet cross quantile correlation (WCQC) analysis for the 0.05th quantile. The first column lists the combinations of different frequencies where potential spillover effects may occur. The second, third, fourth, and fifth columns display the WCQC results for various asset pairs. "Brent" refers to Brent crude oil returns, "BTC" refers to Bitcoin returns, "WTI" refers to Western Texas Intermediate returns, and "Gold" refers to Gold returns.

non-corresponding scales, specifically the week-month and week-year scales. This indicates that a trader with a weekly time horizon who holds Bitcoin for a medium period (up to a trading month) may find Bitcoin acting as a safe haven. Conversely, Bitcoin does not exhibit safe haven properties in the short run (weekly). The WCQC for the week-year scale is negative, suggesting that if a short-term (weekly) trader holds Bitcoin for a longer period (yearly), Bitcoin can serve as a safe haven.

Regarding the Brent/Gold pair, Gold demonstrates safe haven properties at the year-year scale. Furthermore, Gold acts as a safe haven at the week-year and month-year scales. These findings imply that Gold serves as a safe haven in the long term. Moreover, if short- and medium-term traders hold Gold for extended periods, it will function as a safe haven asset. For WTI/Bitcoin, the safe haven property is observed on a week-month scale, indicating that Bitcoin might serve as a safe haven for short-term traders if they hold it for a relatively longer period.

For WTI/Gold, Gold demonstrates safe haven properties mainly on the year-year scale (long run) and acts as a safe haven on week-year and month-year scales as well. Similar to Brent/Gold, these findings suggest that gold functions as a long-term safe haven. If short- and medium-term traders of WTI can hold gold for an extended period, it may provide a hedge against WTI price fluctuations.

Bitcoin's behavior in the short run reflects its speculative nature, potentially resulting in positive correlations during periods of market turmoil. Over longer horizons, Bitcoin exhibits safe haven properties, possibly due to market dynamics. Gold, on the other hand, is considered a traditional safe haven asset due to its relatively stable supply and its role as a hedge against inflation, currency devaluation,

or geopolitical risk. Consequently, gold consistently shows safe haven qualities.

The results indicate that the same asset can be positively correlated with oil at one horizon yet negatively correlated at another. This variation may be due to changes in liquidity preferences, portfolio rebalancing needs, and risk appetites across different trading horizons. Therefore, investors should consider time-horizon matching when selecting safe haven assets. By combining short- and long-horizon positions, investors can mitigate the impact of market shocks and protect their investments.

IV. Conclusion

In this study, we examined the safe haven properties of Bitcoin and Gold against fluctuations in crude oil prices using an enhanced version of Wavelet Quantile Correlation (Kumar & Padakandla, 2022), which incorporates cross-frequency information spillover. Our findings indicate that both Bitcoin and Gold demonstrate cross-frequency safe haven characteristics. Nevertheless, Gold emerges as the superior safe haven asset, corroborating existing literature (Dutta et al., 2020; Selmi et al., 2018). Our results reveal that safe haven properties are contingent on both time and context. While Bitcoin and Gold can function as safe haven assets, the extent and timing of their safe haven effects differ, underscoring the importance of considering cross-frequency approaches in portfolio construction.

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