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PORTFOLIO STRATEGIES FOR FINANCIAL INSTRUMENTS: CO-MOVEMENT, CAUSALITY OF DOLLAR, GOLD, AND BITCOIN DURING CRISIS

Cengiz Karataş[1]

INTRODUCTION

Financial instruments are one method investors use to generate income. Although there are various types, the most commonly used ones are commodities, foreign exchange, or cryptocurrencies with today's technology. In our study, gold, which is at the head of the locomotive, was used as a commodity, the Dollar as foreign exchange, and Bitcoin, which has reached a very high price level today, was used as a cryptocurrency.

Gold has historically maintained its value and is considered a safe haven. Investors often turn to gold during economic uncertainty because it is generally not affected by inflation and financial crises as much as other financial assets. Bitcoin, on the other hand, has gained great popularity in recent years as a digital currency. Due to its decentralized structure and limited supply, some investors see Bitcoin as the "gold" of the future. However, the value of Bitcoin can be quite volatile and carries risks such as regulations, financial crises, and security threats. The dollar is the world's most widely used reserve currency, and many trade and investment transactions are made in dollars. The dollar is a tool affected by central bank monetary policies, interest rates, and global economic conditions. Gold, Bitcoin, and the dollar can be used to create a diversified portfolio for investors, each offering different risk profiles and opportunities. Therefore, the relation, co-movement, and causality between them gain importance especially pre, after, or during crisis periods.

The most important point that the study focuses on is how investors will approach financial instruments during times of crisis. Especially with COVID-19, there has been a need for arguments that will help investors diversify their portfolios and determine their strategies. For example, with the start of COVID-19, investors have directed the amount of money that governments have put into the market to crypto money. As a result, Bitcoin has reached very high levels after the decline it experienced in 2018. However, demand is generally in favor of gold as a safe haven. Gold has become the focus of investors, especially in times of weakness or uncertainty.

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Researchers have generally focused on which asset affects the other and which asset is more inclined. The fluctuations in the American economy have had a negative impact on the country's economy, especially since the dollar is a reserve currency. This situation has also affected people who invest in financial assets. When we look at past years, we see that investors avoid risk, especially during crisis periods, and therefore turn to gold. The importance of our study is to determine which of gold, bitcoin, or dollars has more dominance and the direction of the relationship between them, taking into account the pre- and post-COVID-19 period. In today's economic market and academic literature, the relationship, co-movement, and causality of gold, dollar, and bitcoin have an important place.

In recent years, many studies examining the relationship between gold, dollar, and Bitcoin have been applied in the academic literature. Most of the research was focused on understanding the cause-and-effect relationship between them during crisis or non-crisis periods. Especially in periods of the financial crisis, this cause-effect direction, and co-movement between these major financial instruments for portfolio optimization gains importance. As a result of this necessity, in this study, the coherence times, causality, and co-movement of gold, bitcoin, and dollar measured by WTC about 8 year period from December 2016 to December 2024 which covered some crises, China-USD trade fight, COVID-19 and Russia-Ukraine war, etc. When we look at today's financial market, we see that cryptocurrencies have reached high levels with increasing risk demand. Investors who wanted to escape from risky assets during wartime turned to gold, but especially after the US elections in 2024, investor interest turned to cryptocurrencies under the leadership of Bitcoin. This shows how important that work is.

Ciaian et al. (2016) disproved the long-term connections between Bitcoin and crude oil and the US currency, respectively. In the framework of Turkey, Korkmaz (2018) emphasized the dollar, euro, gold, bitcoin, and the effect of financial investment tool booms on bitcoin returns. It was demonstrated by that the observed bubbles in the returns of gold, the euro, and the dollar decreased the volatility of the returns of bitcoin. She showed that bitcoin's returns were impacted by those of the dollar, euro, and gold. Mokni and Ajmi (2021) examined the causal link between the US dollar and the top five cryptocurrencies at various distributional levels of the return. They discovered that cryptocurrencies, which may serve as both good predictors and a hedge against changes in the US currency, outperform the US dollar in terms of predictive capacity over the COVID era. Palazzi et al. (2021) examined if there is a nonlinear relationship between bitcoin and six currencies that are all denominated in US dollars: the euro, pound sterling, Swiss franc, renminbi, yen, and ruble. They discovered that the euro has a direct effect on bitcoin. Only the renminbi to bitcoin impact is present in the post-break sample, though. Gürsoy and Sökmen (2021) stated in their study that in the long term, investors including gold or bitcoin in the same portfolio will create a risk-reducing effect. In the years prior to and during the COVID-19 epidemic, Kakinuma (2021) examined actual research about the volatility spillover effects and return among Southeast Asian stock markets, bitcoin, and gold. According to Selmi et al. (2021), when risk is high, both gold and Bitcoin react positively to the composite geopolitical risk indicator. This indicates that gold and Bitcoin may both operate as asset safe havens. Rashid et al. (2022) ascertain whether Bitcoin exhibits distinct behavior from gold and FX markets and whether it has any possibility for safe haven, hedging, or diversification. Su J-B and Kao Y-S (2022) examined how the COVID-19 pandemic affects the relation among the gold, oil, stock, currency, and cryptocurrency markets. Zhao (2022) showed that there is a positive correlation between local economic crises and a spike in Bitcoin trading. Trading volume and currency value (and return) are negatively correlated, indicating that higher Bitcoin trading is associated with lower currency prices and depreciation. There is a Granger causation among Bitcoin and crude oil, but not between Bitcoin and gold/US dollars, according to Liu et al., (2023). Asymmetric Granger causation existed among the rise in Bitcoin prices and the decrease in gold prices before COVID-19. There is an asymmetric Granger causal relationship between the drop in the price of Bitcoin and the drop in the price of crude oil following the COVID. Le Thi Thuy et al., (2024) studied the safe-haven role of gold, the dollar, and bitcoin during the period including the Global financial crisis, COVID-19, and the Russia-Ukraine war. In their study, it was understood that gold lost its safe-heaven role in the COVID-19 period. Regardless of the period, only the dollar remained as a balanced safe-haven in times of crisis. Given their important importance in the global economy, Aryan et al. (2024) investigated the dynamic causation among Bitcoin, oil, gold, and economic uncertainty.

WTC is a method to show causality and co-movement among time series. It does not require neither the stationarity of the series nor the linearity of the relation between series compared to the connectedness method. For these reasons, Wavelet was used to investigate the interdependence between financial instruments. Torrence and Compo (1998) defined coherence and cross-wavelet spectra concentrated on atmospheric time series. WTC and cross wavelet transformation methods for two-time series, concentrating on wavelet analysis presented by Grinsted et al. (2004). The use of phase angle statistics was demonstrated in their research to analyze reliance on causal relationships. There were a lot of studies to measure causality and co-movement between financial series via WTC. Kang et al., (2019) found volatility persistence, causality, and phase differences between Bitcoin and gold futures prices. They used WTC which indicated a high level of co-movement at 8–16 weeks frequency between Bitcoin and gold futures prices. Karatas and Unal (2021) examined co-movements of exchange rates through WTC. Goodell and Goutte (2021) analyzed the co-movement between COVID-19 deaths and Bitcoin via WTC analysis. Ozdurak and Karatas (2021) analyzed the co-movements of the biggest technological stocks, FAANG and Microsoft, to see if there was a new technological bubble in the market. Karatas and Unal (2022) analyzed the information flow and co-movement among major stock indices with WTC.

Some authors used methods based on wavelet analysis to investigate the relationship between Dollar, gold, and Bitcoin at different frequencies over time. Aliu et al., (2024) analyzed the effect of bitcoin (BTC) on the dollar index (USDX), gold, and the volatility index (VIX). They discovered that a positive Bitcoin shock considerably raises the price of gold. Tekin et al. (2024) looked at how the price and volatility of Bitcoin (BTC) in Turkiye relate to gold, USD, oil, the VIX index, hedging, and diversification aspects. By WTC analysis they observed strong positive and negative fluctuations of BTC values with gold, oil, USD prices, and the VIX fear index during the epidemic.

In sum, this article aims to enhance existing studies by considering investor preferences about major financial instruments during crisis and last days economic structures. It investigates the correlation between a wide array of instruments using Wavelet coherence analysis over the period ranging from 01/12/2016 to 03/12/2024.

Section 2 starts with Wavelet Coherence, section 4 discusses the outputs of WTC and in the last part, in the conclusion, we interpret the results, and gains of this study.

METHODOLOGY

Wavelet Coherence (WTC)

Wavelet coherence shows the co-movement of two series. If they co-move positively, there are coherent areas in WTC plots that are shown as red to blue colors, representing high to low-level coherence for a specific period.

Wavelet analysis does not require neither the stationarity of the series nor the linearity of the relation between series compared to the connectedness method. For these reasons, Wavelet analysis was used in that study to investigate the interdependence between financial instruments.

Grinsted et al. (2004) invented wavelet tools that were used in that study. The Cross Wavelet Transform (XWT) is created by combining two CWTs (Continuous Wavelet Transforms). XWT displays the mutual strength and relative phase of time series in time-frequency space. The phase difference between this series explains the causal relations. CWT is better at observing the determination of signal frequencies over time and comparing the spectra to those of other signals and a bandpass filter that operates on the x(t) series.

CWT is defined as;

$$W_x(\tau, s) = \frac{1}{\sqrt{s}} \sum_{t=1}^{N} x(t)\varphi^*\left(\frac{t-\tau}{s}\right) \tag{2.1}$$

Morlet Wavelet described below;

$$\varphi(\eta) = \pi^{-\frac{1}{4}} e^{i\omega_0\eta} e^{-\frac{1}{2}\eta^2} \tag{2.2}$$

Here time is η and frequency is ω_0, which is 6 since it provides a good fit between time and frequency domain.

$W_n^X(s)$, W_n^Y (s); X, Y's wavelet transforms and XWT is;

$$\Psi_n^{XY}(s) = W_n^X(s).\, W_n^{Y*}(s) \tag{2.3}$$

Complex conjugate of W_n^Y (s) is W_n^{Y*}(s)

Wavelet coherence (WTC) formed as;

$$R_n^2(s) = \frac{|S(\, s^{-1}\Psi_n^{XY}(s)\,)|^2}{S(\, s^{-1}|W_n^X(s)\,|^2).S(\, s^{-1}|(W_n^Y(s)\,|^2)} \tag{2.4}$$

Smoothing operator is "S".

Phase

Description of WTC' phase angle is;

$$\varphi_{xy}(u, s) = tan^{-1}\left(\frac{I\{S((s^{-1}\Psi_n^{XY}(u, s)))\}}{R\{S((s^{-1}\Psi_n^{XY}(u, s)))\}}\right), \varphi_{xy}\epsilon[-\pi, \pi] \tag{2.5}$$

Here: I and R; complex and reel piece of the power spectrum. The co-movement between series at different scales can be detected by phase angles. If they are co-moved and in phase, the arrows move right. If first lead second, arrows act down (phase angle on [0,$-\pi/2$]) and reverse relation when they act up (phase angle on [0,$\pi/2$]).

DATA

The US dollar index, gold prices against the US dollar, and Bitcoin prices against the US dollar were obtained from Investing.com. The financial instruments were analyzed between 01/12/2016 and 03/12/2024 to cover some crisis periods, especially COVID-19, the China-US economic fight, the Russia-Ukraine war, etc.

RESULTS

Table 1. Descriptive Statistics of US Dollar Index, Gold, Bitcoin

	Mean	Median	Std.Dev	Min.	Max.	Skewness	Kurtosis
Dollar	98.3868	97.57	5.2420	88.59	114.11	0.3028	2.3771
Gold	1688.3177	1749.73	368.8314	1128.43	2786.19	0.5187	2.8491
Bitcoin	24086.023	16691.20	21152.325	752.60	98929.70	0.9324	2.9093

According to descriptive statistics in Table 1, by the value of skewness, the time series distributed normally just bitcoin close to positive skewness. When we compare the variation in time series, by the ratio of sdt.dev to mean, we observe that variation in Bitcoin is highest which is approximately 87%. That also shows that cryptocurrencies are the most volatile financial instruments.

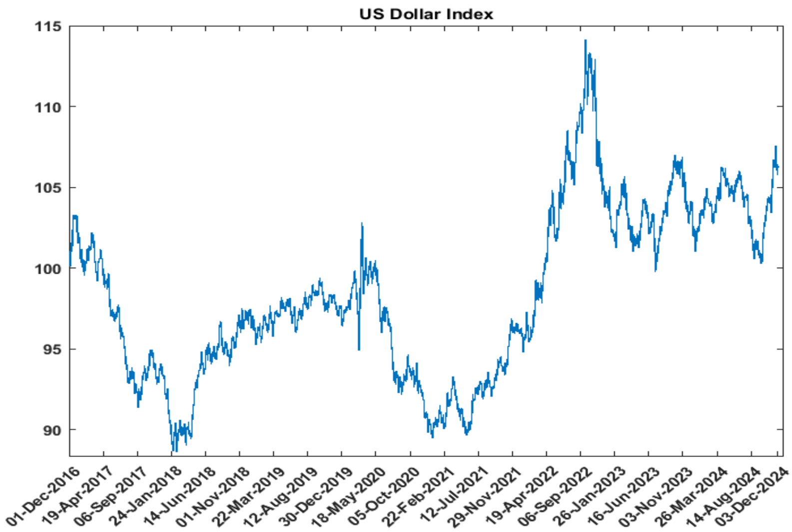

Figure 1 The Aaily Values of the US Dollar Index

The daily prices of the US Dollar are shown in Figure 1. Firstly, If we look left of the graph From Dec.2016 to 2018 there was a decline (could be the result of after Trump was elected, some governmental decisions, an economic fight with China, etc.). Secondly, after COVID-19 started the dollar prices lowered to around $90 until Jul.2021 (could be the result of the Fed supplied a huge amount of dollar to the market and they used it to invest in gold or cryptocurrencies). If we focus on the dates Jan.2018 to Dec.2019 dollar index jumped to $100s from $85s (the US Central Bank, FED made some decisions about the political interest rate and this made the dollar stronger against other financial instruments). The dollar index tested its highest level in 20 years by rising to 114.8 in September 2022 due to concerns about Covid, the Russia-Ukraine War, and the global high interest rate environment. As the impact of these concerns diminished, it fell below 110 as of December 2022 and then fell to 99.6 in July 2023 after expectations that the Fed would end its hawkish steps grew stronger. These days, especially with the American elections, we have seen the dollar gaining strength. Because, it is estimated that in the second Trump term, taxes will be reduced, high tariffs will be imposed and immigration-restricting policies will be taken. This will increase inflation and cause the US Federal Reserve to slow down its interest rate cuts. I expect this to have an effect that will support the dollar.

Gold prices in Figure 2 are more stable if we compare them with the dollar and Bitcoin. There has been a positive rising trend for 8-year periods from 2016 to today. If we analyze the COVID period gold also showed a decline but not as much as the dollar. In Aug.2020 reached $2075 then lowered to $1620 in Sep.2022 (instead of gold people directed their investments to cryptocurrencies in the first part of COVID-19, and to the dollar in the second period, as the dollar strengthened with the FED decisions). After Sep.2022 to the present, gold entered a bullish channel and reached very high levels, it touched $2790 in 30.Oct.2024 because of dollar lost its power. However, these days it has lost some of its strength, especially with the appreciation of the dollar, cryptocurrencies and American assets after Trump elected in Dec.5, 2024.

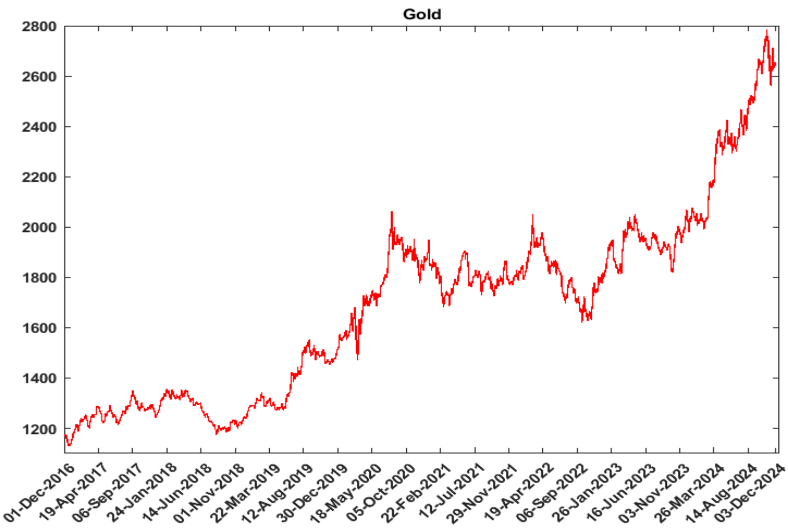

Figure 2 The Daily Values of the Gold

The most volatile structure was in the bitcoin shown in Figure 3, when we compare it with the other two instruments. After a jump which started in 2017 at about $19700, Bitcoin lowered $3000s in Dec.2018.

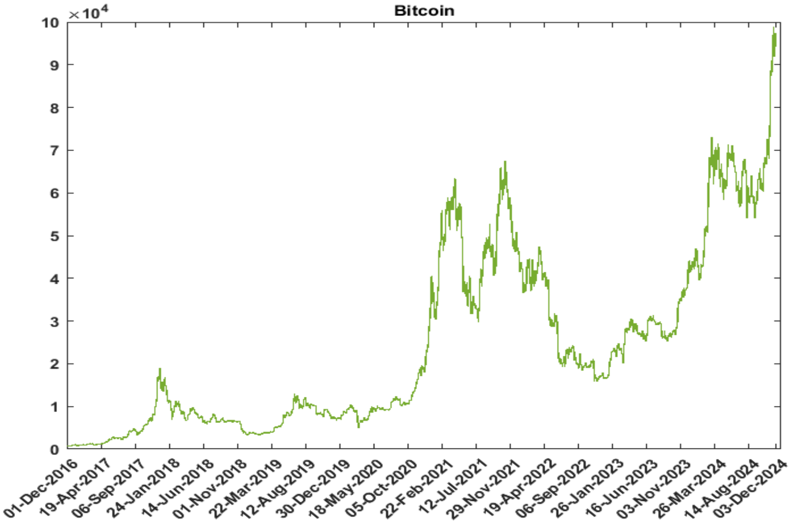

Figure 3 The Daily Values of the Bitcoin

If we look at the graph, with the declaration of COVID-19 as a pandemic in the world, it made the biggest leap in its history and reached $69,000 on Nov.10, 2021, after minor fluctuations. Since then, the perception towards cryptocurrencies has experienced a downward trend due to the decrease in trust, the move away of large investors, the policies of governments, and their risky structure the value of it has fallen to $15,700 on Nov.14, 2022. With the increase in approvals for crypto, the demand of investors, the approval of cryptocurrencies ETFs, the need for the blockchain system due to technological developments and expectation of Trump elected, it has increased again and exceeded the $70,000 level in Aug. 2024. With the election of Trump, who announced that he would support cryptocurrencies and make America the reserve country of Bitcoin, the process that started with the election of President of Trump on Nov. 5, 2024, reached its peak and passed the historical threshold of $100,000. Bitcoin, which is currently the favorite of investors, has once again shown that it is a candidate to be the future gold by leaving silver behind.

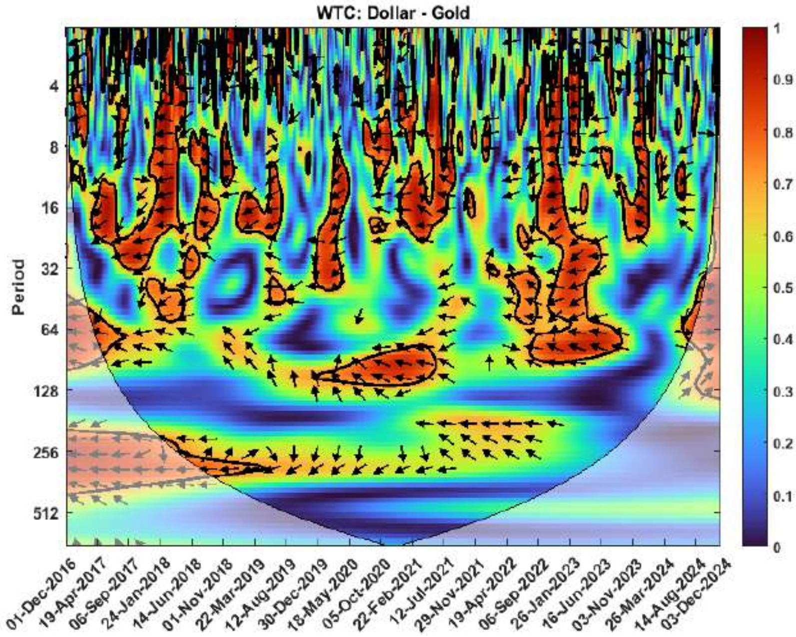

Figure 4 WTC of US Dollar Index, Gold

According to Figure 4, the US Dollar Index and Gold have coherent areas and show negative co-movement since arrows move left for the whole time period, so these two instruments can be substituted into to same portfolio. The coherent areas exist firstly, from Dec.2016 to Jun.2018 for all investment horizons with negative side arrows which means they move in opposite directions and could be affected by US government decisions and the war that started in the Middle East. Secondly, from Dec.2019 to Jul.2021, by the start of COVID-19 in the medium run the arrows moved left up which means Gold affected the dollar negatively during this period. It may be a result of after FED decisions investors tend to gold because of the losing power in the dollar. This also proves that people prefer gold initially in crisis times. Thirdly, from Sep.2022 to Sep.2023 there was a coherence area and negative relationship between the dollar and gold, we can also easily see that opposite movement by Figure 1 and Figure 2. Lastly, after Aug.2024 the relation turns to positive, and right up arrows state gold was the leading dollar in the medium run (16-128 day cycles).

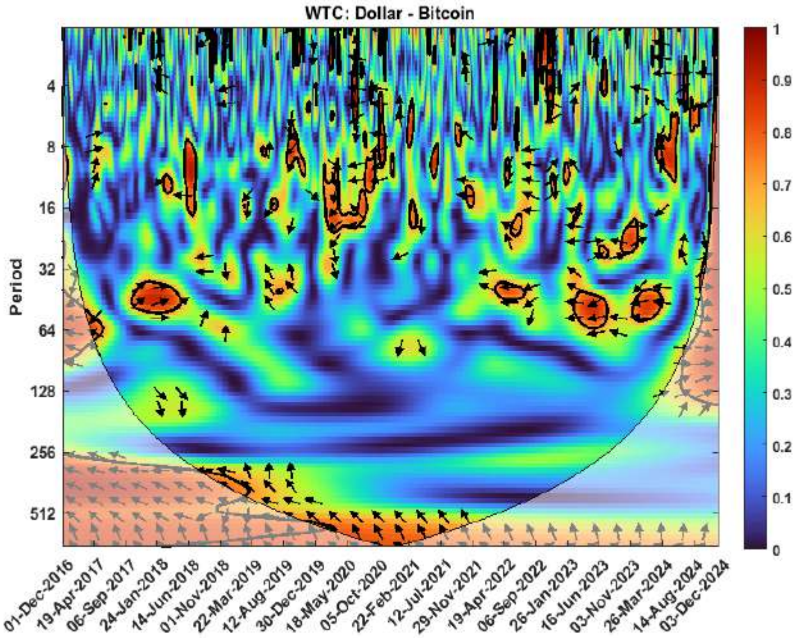

Figure 5 WTC of US Dollar Index, Bitcoin

The US Dollar Index and Bitcoin wavelet coherence result shown in Figure 5, they have coherent areas and show negative co-movement since arrows move left for the whole time period except last part of graph from June.2024 to today, so these two instruments can be substituted into to same portfolio, since they moved to different directions approximately 4 year and they didnt have any relation about 4 years (blue area from May.2020 to June.2024 after 64 day cycles). The coherent areas exist firstly, from Dec.2016 to Dec.2019 in the long run (after 256 day cycles) and Dollar dominate Bitcoin negatively (left up arrows), which could be result of Dollar value decrease because of US governmental decisions, China-US trade fight from 2016 to 2018, in that period Bitcoin value jumped. However after 2018 FED increased political interest rate which support dollar until COVID, at the same time a small decrease happened in Bitcoin. At the starting period of COVID from Dec.2019 to Nov.2020 at 4-32 day cycles (short run) and left down arrows showed at that period Bitcoin caused Dollar negatively, could be affect of huge amount of dollar which supplied by US Govenments invested to Bitcoin by people. Lastly, after June.2024 the relation turns to positive, and right up arrows state Bitcoin was affecting the dollar in the medium run (16-128 day cycles). Which is the result of cyrptocurrencies accaptence by institutions, several cyrptocurrencies ETFs and the Trump effect since he support the cyrptocurrencies. At that time also Dollar index increased, and after Trump elected in Nov.5, 2024, the Bitcoin passed the barrier of $100,000 and also Dollar get stronger.

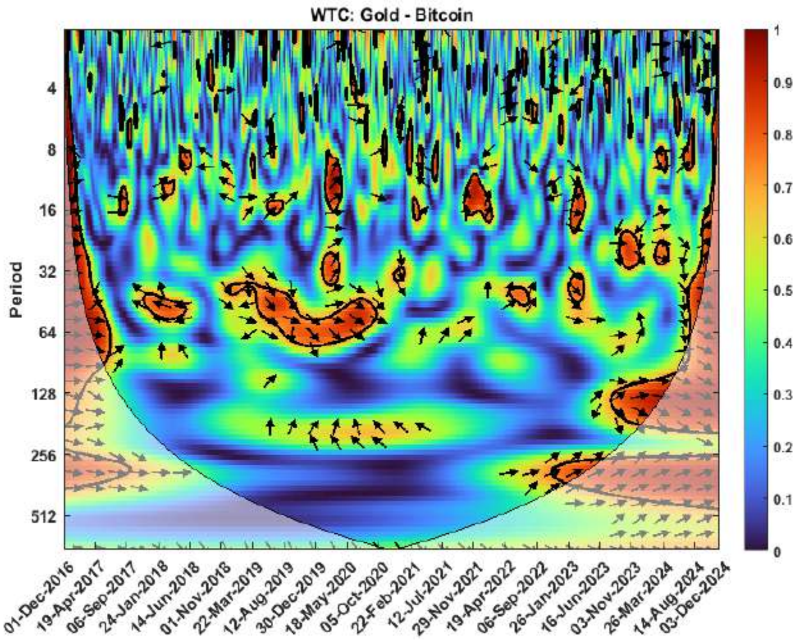

Figure 6 WTC of Gold, Bitcoin

In Figure 6, the Gold and Bitcoin prices co-moved from Dec.2016 to Aug.2017 in medium,long run (8-256 day cycles) and they showed same structure. From Nov.2018 to Oct.2020 another coherence area were exist at 32-64 day cycles and Gold dominated the Bitcoin since arrows move right-down. Especially at the starting of COVID-19 at 8-32 day cycles from Dec.2019 to May.2020 Bitcoin affect gold (up arrows) positively which means at the early stage of pandemic, Bitcoin took the information firstly then transfered to gold. Again we understood they had same behaviour in crisis. Lastly, After Dec.2022 another co-movement exist between them by the decline in dollar. In medium run (16-128 day cycles) down arrows represent Gold caused Bitcoin positively and in long run (256-512 day cycles) up arrows showes that Bitcoin leading. Which means long term relation between them dominated by Bitcoin. But the last days value of Gold decrease and Bitcoin jumped after US elections which not affect our WTC graph structure since just 1 month.

Table 2. Correlation Between US Dollar Index, Gold, Bitcoin

	Dollar - Gold	Dollar- Bitcoin	Gold- Bitcoin
Correlation	-0.4173	-0.2440	0.5362

The correlations between variables were shown in Table 2. There was a negative correlation between Dollar, gold and bitcoin, but positive correlation exist between Gold and Bitcoin. According to that table we can state that Bitcoin may be placed on the portfolios instead of Gold. Negative correlation in Table 2 and negative price movement in Figure 4 and Figure 5 conclude that Dollar is a safe heaven for Gold and Bitcoin investors. Also, the phrase "future gold" used by some researchers and experts for Bitcoin can also be supported by the results showing the positive relationship and the same price movements in Table 2 and Figure 6. Especially at the starting period of COVID-19, dollar lost its power and this effect investor preference, which turned to Gold and Bitcoin. During the crisis periods Bitcoin had more volatile characteristic but gold showed more stable structure. Nowadays, Trump's election as president and his positive thoughts about cryptocurrencies have increased the price of Bitcoin above 100,000 dollars, and there has been a decline in gold prices.

CONCLUSION

Investors and managers, when determining their portfolio strategies, decide by taking into account the causality of the relationship between financial assets and instruments. Since financial assets may behave differently especially during crisis periods, the analysis of the relationship during these periods will also be an important indicator for investors.

In this study, I focused on the subject I mentioned above. As financial instruments, the values of US Dollar index, Gold and Bitcoin prices from 2016 to the present were used, and the relationship between each other and causality were analyzed in different investment horizons. Since the analysis of assets during crisis periods is another purpose of this study, crisis periods were also interpreted, including the COVID-19 period.

In my study, the Wavelet Coherence method was used to analyze the relationship, causality and direction between Bitcoin, Gold and Dollar in different investment horizons. According to the results obtained, Dollar, Gold and Bitcoin dominate, but the effect of the Dollar remains limited in crisis periods. Gold exhibits a more stable structure compared to the other two assets. It affects Bitcoin in times of crisis, including the COVID period, but in the early periods of COVID, while short runs affect the Dollar, gold is negatively affected by the Dollar in medium runs. Especially since the summer of 2024, all assets have moved in the same direction. This actually shows that the market analysis, including news flows, should be done carefully before investing, regardless of the period.

In conclusion, this study has shown that the Dollar affects Gold and Bitcoin, gold has a more balanced structure in crisis periods, gold and Bitcoin exhibit the same price movement, therefore they should not be in the same portfolio, and

Bitcoin will be a major investment tool in the future. My study can be expanded by including different assets, using different methods, and considering longer time periods. Also, these results will help investors and portfolio managers choose a safe haven for their portfolios, especially during volatile market periods.

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