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Shelter in Uncertainty: Evaluating Gold and Bitcoin as Safe Havens Against G7 Stock Market Indices During Global Crises

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Abstract: This paper investigates the hedging and safe haven capacity of gold and Bitcoin against the G7 stock market indices during the COVID-19 pandemic, the Russia-Ukraine military conflict, and the Silicon Valley Bank collapse. Using a novel Quantile-VAR connectedness approach, the results show that, at the median quantile, both gold and Bitcoin act as effective hedges during normal market conditions and strong safe-haven assets during the three crises. Gold emerges as the most prominent safe haven asset, outperforming Bitcoin, especially during the war and the SVB collapse. Among the G7 stock market indices, the Japanese and the American stocks may be used as risk diversifiers during crises. As for the rest of the G7 stocks, they are regarded as "risk-on" investments. Next, we assessed the robustness of our results at various quantiles. We found them to be generally consistent with the outcomes obtained at the median quantile, with one exception related to the S&P500.The results show that the repercussions of the COVID-19 pandemic and the war are much stronger than the American banking crisis.

Keywords: COVID-19 health crisis; Russia-Ukraine war; SVB collapse; safe haven assets; G7 stock market indices; Quantile-VAR.

JEL classification: C58; G01; G10; G11; G15; G21.

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1. INTRODUCTION

In the last decade, we have witnessed numerous crises, including the latest COVID-19 pandemic detected in Wuhan, China on December 31st, 2019, and the ongoing geopolitical tensions observed in the Russia-Ukraine conflict since February 24, 2022. Both of these crises have exerted significant and complex influences on global stock markets (Baker *et al.*, 2020; Jeribi and Snene-Manzli, 2020; Boungou and Yatié, 2022; Thorbecke, 2022; Fakhfekh *et al.*, 2023; Florian and Sascha, 2023). In the initial stages, the pandemic initiated an intense and widespread decline in the market due to the enormous economic disturbances it generated. Governments across the globe enforced rigorous measures to contain the virus's transmission, resulting in the shutdown of businesses, reduced consumer expenditures, and the disruption of global supply networks. These factors, combined with investor concerns, contributed to increased market instability and significant drops in global stock markets, particularly in the G7 stock markets (Caporale *et al.*, 2022). For instance, the American stock index (S&P500) plunged by more than 9% in March 2020. Similarly, Asian stocks experienced a substantial decline, as evidenced by Japan's key NIKKEI index concluding with a 4.4% decrease on March 12, 2020. In addition to the meltdown in the American and Asian stock markets, European stock markets also experienced significant downturns. For example, the FTSE100, the main stock index in the United Kingdom, registered a decline exceeding 10% on its most challenging day since 1987. Stock indices in France and Germany also recorded declines exceeding 12%[1].

On the other hand, the ongoing conflict between Russia and Ukraine has initiated geopolitical instability and raised worries about global security and energy supplies. Consequently, stock markets in G7 countries have experienced periodic changes in response to escalating war events, affecting investor sentiment and market performance (Boungou and Yatié, 2022; Fakhfekh *et al.*, 2023; Kayral *et al.*, 2023). Ahmed *et al.* (2023) reveal that European stock markets responded negatively to the Russia-Ukraine crisis due to heightened political uncertainty, geographic proximity, and the consequences of recent sanctions imposed on Russia. Alam *et al.* (2023) state that the Russian-Ukrainian war had a significant impact on the volatility spillover from and to commodities in G7 stock markets. Also, Boubaker *et al.* (2022) discovered that the 2022 Russian invasion of Ukraine resulted in negative returns for global stock market indexes.

More recently, on March 10, 2023, Silicon Valley Bank (SVB), the sixteenth most prominent financial institution in the United States, experienced its most significant breakdown since the 2008 global financial crisis, resulting in the loss of billions of dollars in deposits and financial holdings. SVB's collapse occurred against the backdrop of an expanding technology sector during the COVID-19 pandemic, coinciding with a significant surge in customer deposits, totaling billions of dollars. SVB directed substantial portions of its surging deposits into investments such as U.S. government bonds and securities backed by mortgages. This, coupled with rising interest rates, resulted in a severe reduction in the bank's investment value. In fact, this decline sparked fear among depositors and a rush to withdraw their money. As reported by Yousaf and Goodell (2023), Silicon Valley Bank (SVB) customers withdrew $42 billion in funds in a single day. This withdrawal trend continued for a duration of 10 hours, resulting in a loss of $4.2 billion per hour, which translates to over $1 million per second (Yousaf *et al.*, 2023).

The collapse of financial institutions has the potential to exert a substantial influence on global stock markets, causing disruptions within the financial system and impacting investor confidence. For instance, on that particular day, the S&P500 declined by 1.4%, concluding the week with a 4.5% decrease, making it the most challenging week of the year for the index. This decline was led by SVB's fellow banks, such as Western Alliance Bancorp, which plummeted by more than 20%, and Signature Bank in New York, which experienced a nearly 23% decline[2]. Additionally, the British stock index (FTSE100) concluded with a 1.67% decrease following this crisis[3]. Pandey *et al.* (2023) studied the repercussions of Silicon Valley Bank's (SVB) collapse on global stock markets, finding that it had adverse effects, especially in advanced markets compared to emerging ones. Aharon *et al.* (2023) state that stock markets in the Middle East, Europe, Latin America, and Africa negatively reacted to the SVB crisis. Meanwhile, Akhtaruzzaman *et al.* (2023) explored whether the collapse of Silicon Valley Bank triggered financial contagion in the G7 nations. They found that this contagion was of brief duration and primarily affected international banks, with restricted effects on other sectors.

The ongoing health and political crises, along with the recent American banking crisis, exhibit a heightened level of complexity compared to preceding financial crises. This has motivated investors to actively seek uncorrelated assets to mitigate risk and safeguard their investment portfolios. In fact, gold and Bitcoin have garnered acknowledgment as safe-haven assets in the financial sphere. Gold has a long-standing reputation as a store of value and a reliable safe haven asset during times of turmoil (Baur and Lucey, 2010; Baur and McDermott, 2010; Baur and McDermott, 2016; Shahzad *et al.*, 2019; Azmi *et al.*, 2023; Fakhfekh *et al.*, 2023; Nekhili *et al.*, 2023). On the other hand, Bitcoin, a relatively more recent addition to the safe haven classification, has demonstrated potential as a digital substitute. It has piqued the interest of numerous investors as a tool for hedging against declines in the stock market (Baur *et al.*, 2018; Al-Yahyaee *et al.*, 2019; Bouri *et al.*, 2020a; Bouri *et al.*, 2020b; Fakhfekh and Jeribi, 2020; Aloui *et al.*, 2023; Fakhfekh *et al.*, 2023; Jlassi *et al.*, 2023).

Apart from the significant impact displayed by the COVID-19 pandemic and the ongoing Russia-Ukraine conflict on global stock markets, the SVB bankruptcy is also expected to have substantial consequences for worldwide stock markets, considering the global importance of the banking industry. In fact, a large number of studies have concentrated on the impact of the COVID-19 pandemic on financial markets and the hedging and safe haven ability of different asset classes during this health crisis. However, the existing literature still lacks studies that specifically concentrate on the effects of military conflicts and banking system collapses on the global financial markets.

So, motivated by these high-volatility periods and following Baur and Lucey (2010); Rizvi *et al.* (2022); Wang *et al.* (2022), we aim to reinvestigate the hedging and safe haven abilities of gold and Bitcoin against the G7 stock market indices during the COVID-19 pandemic, the Russia-Ukraine military conflict, and the SVB bankruptcy. In fact, we concentrate our attention on the G7 stock markets for various reasons. These markets belong to the most advanced economies globally and frequently exhibit divergent economic conditions and responses during challenging periods, such as the European debt crisis, wherein Bitcoin and gold may demonstrate distinct reactions (Shahzad *et al.*, 2019). This encourages us to examine these stocks' responses during more recent crises such as the COVID-19 pandemic, the Russia-Ukraine military conflict, and the SVB collapse. Moreover,

numerous studies indicate the diversity in dynamic interconnections across each G7 country, rendering the analysis of equity responses to Bitcoin and gold particularly intriguing.

In this paper, we applied the novel Quantile-VAR approach of Chatziantoniou *et al.* (2021) to examine the connectedness among these assets at the median quantile and then across different quantiles. The findings demonstrate that Bitcoin and gold are net receivers of shocks. This suggests that they are perfect hedging tools during normal times and strong safe haven assets against the G7 stock market indices during the three crises. The yellow metal is found to be the most resilient safe haven asset in our study, and it outperforms Bitcoin, especially during the war and the SVB failure. Among the G7 stock market indices, NIKKEI is the most significant net receiver of shocks during the three crises, followed by the S&P500, suggesting their possible use as risk diversifiers during periods of crises. As for the rest of the G7 stock market indices, they are considered significant net transmitters of shocks and typically experience price variations during periods of crises. The results also show that the repercussions of the COVID-19 pandemic and the war are much stronger than those of the American banking crisis. Additionally, the contagion among digital and financial assets during the SVB crisis was of brief duration, as the collapse exhibited relatively restricted effects in other markets compared to the banking sector (Akhtaruzzaman *et al.*, 2023).

Our study contributes to the literature in several ways. It makes a substantial contribution to the understanding of financial markets during turbulent times by investigating the hedging, diversifying, and safe haven attributes of Bitcoin and gold against G7 stock market indices. Utilizing the quantile-VAR methodology at both the median quantile and various quantiles, this research offers a nuanced analysis that goes beyond conventional approaches. By examining the distinct periods of the COVID-19 pandemic, the Russia-Ukraine war, and the SVB collapse, the study provides a comprehensive examination of the resilience of Bitcoin and gold across different geopolitical and economic challenges. The findings of this research shed light on the effectiveness of these assets in mitigating risk and enhancing portfolio performance, contributing valuable insights to both academic and practical perspectives on portfolio management during times of crisis.

The rest of our paper is structured as follows: Section 2 provides an overview of the relevant literature. Section 3 outlines the data and descriptive statistics. Section 4 presents the empirical methodology. Section 5 provides the empirical findings. Finally, Section 6 concludes the paper.

2. LITERATURE REVIEW

Black swan occurrences have the ability not only to disrupt the stable growth of the worldwide economy but also to pose a significant danger to financial market participants. Recently, global financial markets have experienced substantial stress, volatility, and significant uncertainties due to the COVID-19 health crisis, the ongoing Russia-Ukraine military conflict, and the Silicon Valley Bank crisis (Ghabri *et al.*, 2022; Ghorbel *et al.*, 2022a; Ghorbel *et al.*, 2022b; Frikha *et al.*, 2023; Pandey *et al.*, 2023; Yousaf and Goodell, 2023; Yousaf *et al.*, 2023). Unlike previous economic and financial downturns, the dynamics driving these recent crises have presented a variety of difficulties and risks, pushing investors to search for uncorrelated assets to safeguard their stock market portfolios (Wang *et al.*, 2022; Wen *et al.*, 2022).

In fact, Baur and Lucey (2010) were the first to define hedging, diversifying, and safe-haven assets. According to them, hedging assets are the financial assets that allow investors to protect their portfolios during normal times. Diversifying assets are the financial assets that allow investors to reduce portfolio risk and enhance diversification during both normal times and periods of stress. Whereas, safe-haven assets are financial assets that enable investors to protect their portfolios during times of economic uncertainty, market volatility, or geopolitical turmoil.

2.1 The diversifying, hedging, and safe haven ability of gold

Gold is the most frequently mentioned asset in the literature when it comes to hedging and finding a secure refuge during periods of turmoil. Its uncorrelated nature with other financial assets makes it an appealing option for investors seeking to diversify their stock market portfolios and protect against market volatility (Baur and McDermott, 2010; Chkili, 2016; Ghorbel *et al.*, 2022a; Ghorbel *et al.*, 2022b; Shahzad *et al.*, 2022). In the context of the COVID-19 pandemic, Ghabri *et al.* (2022) found that gold stands out as the most promising hedging and safe-haven asset when compared to Bitcoin. According to Wen *et al.* (2022), gold serves as a safe haven asset that provides a mitigating refuge for both the oil and stock markets during the COVID-19 pandemic. Ali *et al.* (2021) reassessed the diversification ability of the yellow metal during the COVID-19 outbreak. Their findings reveal that gold reduces the downside risk of Islamic equity portfolios during this health crisis. Abdullah (2023) studied gold and Bitcoin's performance as hedging and safe haven assets for the US Islamic stock index during the COVID-19 outbreak and the Russia-Ukraine conflict. Their research revealed that gold, given its stability and negative correlation with the stock index, is better for diversification and hedging, reducing overall portfolio risk.

Widjaja and Havidz (2024) assessed the safe haven properties of gold and cryptocurrency in conventional and Islamic markets. Their findings show that gold is a strong safe haven asset for both stocks and bonds in both types of markets, especially during market declines. Gold is considered a reliable safe haven in both emerging and developed nations. On the other hand, cryptocurrency demonstrates better safe haven qualities in developed countries compared to emerging ones. The authors confirm that gold is the preferred choice as safe haven during economic instability, particularly for investors seeking Sharia-compliant options. Employing the T-GARCH-ADCC framework, Fakhfekh *et al.* (2023) analyzed gold's hedging, diversifying, and safe-haven properties in connection with G7 stock markets amidst the Russian-Ukrainian military conflict. Their findings lend support to gold's potential as a robust safe-haven asset for G7 investors during this political crisis. Using the event study methodology, Azmi *et al.* (2023) examined the consequences of the collapse of Silicon Valley Bank on 11 major international assets, including gold. They asserted that the yellow metal served as a safe haven on the day of the event. Furthermore, Baur (2023) states that gold acts as a safe haven during this American banking crisis.

However, only a limited number of studies question the capacity of gold to serve as a hedge and a safe haven. For instance, Hood and Malik (2013) assessed the function of gold as a safe haven for the US stock market during periods of significant stock market downturns. Their investigation reveals that gold plays a limited safe haven role for the US stock market. Shahzad *et al.* (2019) compared the safe haven abilities of gold and Bitcoin for global stock markets. Their findings suggest that, in some cases, both assets act as poor safe havens. Jeribi and Snene-Manzli (2020) examined the hedge and safe haven abilities of gold for the Tunisian

stock market during the COVID-19 pandemic. They suggest that gold does not exhibit hedging or safe haven characteristics during the pandemic.

Będowska-Sójka and Kliber (2021) investigate the safe haven attributes of gold in relation to stock markets. They observe that the protective quality of gold against stock market indices diminished during the crisis triggered by the COVID-19 pandemic. Using the DCC-GARCH approach, Choudhury *et al.* (2022) investigate the efficacy of gold as a safe haven for stock markets during various health crises, including the COVID-19 pandemic. Their findings suggest that gold does not exhibit strong safe haven characteristics for investors during different health crises. Gambarelli *et al.* (2023) used ARDL and NARDL techniques to assess gold's safe haven ability in relation to European stocks during the COVID-19 market downturn. Their findings surprisingly show that gold did not perform as the expected protective haven during this crisis.

2.2 The diversifying, hedging, and safe haven ability of cryptocurrency

In addition to the yellow metal, cryptocurrencies have also captured the attention of investors as hedging and safe haven instruments. For instance, Bitcoin, characterized by its lack of correlation with conventional assets (Baur *et al.*, 2018; Bouri *et al.*, 2020) and its independence from the monetary policy climate (Narayan *et al.*, 2019), has the capacity to mitigate portfolio risk and offer hedging advantages during times of financial market turbulence (Dyhrberg, 2016; Bouri *et al.*, 2020b; Gil-Alana *et al.*, 2020; Bouri *et al.*, 2020 ; Frikha *et al.*, 2023). Mokni *et al.* (2021) explore Bitcoin's hedge and safe-haven characteristics in relation to U.S. economic policy uncertainty, confirming its safe-haven status during bearish Bitcoin market conditions. Koutmos *et al.* (2021) assess cryptocurrencies as hedging instruments, highlighting Bitcoin's effectiveness in hedging during the COVID-19 pandemic. Abdullah (2023) also underscores Bitcoin's status as a reliable safe haven and hedging instrument, particularly within the context of the COVID-19 pandemic. Jlassi *et al.* (2023) employed a copula methodology to investigate the tail dependence between the returns of G7 stock markets and the returns of various cryptocurrencies during the recent health and geopolitical crises. The findings emphasize the potential of cryptocurrencies to contribute to risk diversification within stock markets, particularly during times of crisis.

Kayral *et al.* (2023) used the DVECH-GARCH model to assess the hedging capacity of Bitcoin and gold for the G7 stock indices during the COVID-19 pandemic and the Russian-Ukrainian military conflict. Their findings show that prior to the COVID-19 outbreak, Bitcoin and gold were effective hedging tools. However, during the pandemic and the conflict, they showed diversification properties. The study also indicates that both gold and Bitcoin can be considered safe-haven assets. Abdelmalek and Benlagha (2023) used a smooth transition regression model to analyze the hedge and safe-haven attributes of Bitcoin against a diverse array of traditional assets, both before and during the COVID-19 pandemic. Their investigation demonstrates Bitcoin's ability to function as a safe-haven instrument during the pandemic and as a hedging instrument before the COVID-19 outbreak. Fakhfekh *et al.* (2023) also assert that Bitcoin serves as an excellent diversifier for the Tunisian stock market indices during the COVID-19 pandemic.

In a more recent study, Wang *et al.* (2023b) investigated the impact of the Silicon Valley Bank's (SVB) downfall on cryptocurrency markets. Their findings revealed that the SVB

failure did not lead to the deterioration of digital currencies; instead, they demonstrated resilience. Jin and Tian (2023) conducted an examination of Bitcoin's safe haven performance during the SVB crisis. Their findings support Bitcoin's role as a safe haven during this American banking crisis. They also assert that Bitcoin outperformed gold in terms of both returns and volatility stability.

In contrast, due to the heightened degree of volatility associated with Bitcoin (Cheema *et al.*, 2020; Fakhfekh and Jeribi, 2020; Jeribi and Masmoudi, 2021), effectively managing its risk becomes inherently complex for investors (Yermack, 2015), potentially making it less suitable as a safe haven asset (Shahzad *et al.*, 2019; Conlon *et al.*, 2020; Jusoh *et al.*, 2023). For example, Conlon and McGee (2020) stated that Bitcoin failed as a safe haven against the S&P500 stock index during the COVID-19 pandemic. Conlon *et al.* (2020) also revealed that Bitcoin lost its safe haven status against stock markets during the pandemic. Likewise, Corbet *et al.* (2020) reported that gold exhibited significantly superior performance compared to Bitcoin in mitigating the risk associated with the Chinese financial market. Selmi (2022) revealed that the efficacy of Bitcoin as a hedge showed signs of decline following the occurrences of the COVID-19 pandemic and the Russia-Ukraine conflict.

By applying the Markov regime-switching regression approach, Rashid *et al.* (2023) conducted a comprehensive analysis of Bitcoin's diversification, hedging, and safe-haven capabilities for financial investors. Their empirical findings indicate that Bitcoin does not serve as a safe haven for any of the studied assets. Jeribi *et al.* (2020) also state that cryptocurrencies were unsuccessful as safe havens during the COVID-19 outbreak when considering the BRICS and GCC stock markets.

Additionally, Ghorbel *et al.* (2022a) indicated the limited ability of cryptocurrencies to function as a safe haven against the G7 stock markets during the COVID-19 pandemic. Wen *et al.* (2022) also compared the safe haven abilities of gold and Bitcoin against oil and stock markets during the COVID-19 pandemic and found that Bitcoin is not a safe haven. Jusoh *et al.* (2023) investigated the correlation between Bitcoin and regional Islamic stock indexes during the COVID-19 pandemic and the Russian-Ukrainian conflict, concluding that Bitcoin does not serve as a reliable safe haven. Béjaoui *et al.* (2023) studied the correlation between cryptocurrencies and G7 stocks during the same crises, also finding that cryptocurrencies were not effective as safe havens.

Ali *et al.* (2023) used the TVP-VAR model to study the spillover of returns and volatility among major cryptocurrencies after the Silicon Valley Bank's downfall. Their findings indicate increased interconnectedness in terms of returns, while volatility interconnectedness remained constant. Conventional cryptocurrencies were identified as the primary sources of transmitting both return and volatility spillovers, suggesting their failure as safe havens. Additionally, Yousaf *et al.* (2023) reported that the Silicon Valley Bank's failure resulted in substantial and unfavorable abnormal returns for Bitcoin. Galati and Capalbo (2023) examined the extent to which the collapse of the Silicon Valley Bank transmitted contagion throughout cryptocurrency markets. Their research shows signs of volatility spillover between prominent stablecoins and Bitcoin.

Based on the information stated above, although both gold and Bitcoin show significant adaptability during periods of instability, the recent health, political, and financial crises have raised doubts about their ability to diversify, hedge, and serve as safe-haven assets. This has intensified the necessity to reassess these attributes and evaluate their effectiveness, particularly against stock markets.

3. DATA AND DESCRIPTIVE STATISTICS

3.1 Data

Our research timeframe spans from January 4, 2016, to July 5, 2023, encompassing the COVID-19 pandemic, the Russia-Ukraine military conflict, and the recent Silicon Valley Bank downfall. Our data consists of 1939 daily observations of the two most recognized safe haven assets, namely gold and Bitcoin, and the most developed stock market indices, namely the G7 stocks, which correspond to the United States (S&P500), the United Kingdom (FTSE), Japan (NIKKEI), France (CAC 40), Germany (DAX 40), Italy (FTSE MIB), and Canada (S&P TSX). Data regarding Bitcoin was collected from the website www.coindesk.com, while data for the G7 stock indices and gold prices were obtained from DataStream. All the price sequences have been converted into natural logarithms and are calculated as follows:

$$r_{it} = log\left(\frac{p_{i,t}}{p_{it-1}}\right)$$

where $p_{i,t}$ represents the closing price of asset i at time t.

3.2 Descriptive statistics

The descriptive statistics summary of the return series is presented in Table no. 1. The statistical summary of the variance elucidates that gold displays the lowest volatility, thus maintaining its status as the most secure asset compared to Bitcoin, particularly during a crisis. Additionally, it shows superior mean yields. This finding aligns with the research of Ghabri *et al.* (2022); Abdullah (2023); Fakhfekh *et al.* (2023); Wang *et al.* (2023a); Widjaja and Havidz (2024), all of whom assert that gold demonstrates a more pronounced safe-haven capacity than Bitcoin during the COVID-19 crisis and the Russia-Ukraine military conflict.

Among the array of the G7 stock market indices, FTSE and FTSE.MIB exhibit the highest mean returns, while the S&P 500 shows the lowest yield. Moreover, the FTSE demonstrates the highest volatility; conversely, the remaining G7 stock benchmarks exhibit lower volatility, establishing them as the most secure indices, with the FTSE stock index standing out as the most volatile.

The skewness metrics illustrate leftward asymmetry in the marginal distributions of all digital and financial assets, as they are characterized by negative values. Subsequently, kurtosis measures are used to assess the presence of either leptokurtosis (heavy-tailed) or platykurtosis (light-tailed) distributions concerning a Gaussian distribution. The obtained elevated figures validate the presence of fat tails in return distributions, except for gold and NIKKEI, which exhibit small values. Furthermore, the hypothesis of a Gaussian distribution is invalidated by the Jarque-Bera examination, suggesting that all digital and financial assets deviate from a normal distribution. As indicated by the ERS unit root test, all the returns exhibit stationarity at the 1% significance level. The outcomes of the Ljung-Box assessment reject the null hypothesis of no autocorrelation within both return and squared return sequences, implying the potential presence of volatility clustering within each respective return dataset.

The descriptive statistics presented in Table no. 1 have been thoroughly analyzed, revealing several specific statistical characteristics for the financial variables under consideration. These characteristics include volatility measures, mean returns, skewness,

kurtosis, deviations from normality, and indications of stationarity and autocorrelation within the return series. Additionally, leftward asymmetry in marginal distributions and elevated kurtosis suggest non-normality and the presence of fat tails in return distributions, findings corroborated by the Jarque-Bera examination. This justifies our later choice of the quantile vector autoregression (Q-VAR) approach which is used to model the dynamic interactions among assets at different quantiles of the distribution. This methodology accounts for potential asymmetries and nonlinearities in asset relationships, aligning with the observed statistical characteristics such as skewness and kurtosis. Moreover, the ERS unit root test confirms the stationarity of returns. At the same time, the Ljung-Box assessment addresses autocorrelation and volatility clustering within the dataset, ensuring that the chosen method appropriately captures the underlying characteristics of the financial variables.

The Kendall correlations between Bitcoin, gold, and the G7 stock indices are presented in Table no. 2. This table offers an initial glimpse into the safe haven ability of the different assets until further examination. The results indicate that the correlation between Bitcoin and the G7 stock market indices is significantly positive, except in the case of NIKKEI, suggesting the diversifying ability of this digital asset (Bouri *et al.*, 2017; Bouri *et al.*, 2020a; Fakhfekh *et al.*, 2023; Jlassi *et al.*, 2023; Kayral *et al.*, 2023; Rashid *et al.*, 2023). As for gold, its correlation with the G7 stock markets is significantly negative only for the German (DAX40), French (CAC40), Italian (FTSE-MIB), and Canadian (SP-TSX) stocks. This supports the hedge ability of the yellow metal during periods of stability and its safe-haven ability during periods of crisis (Baur and Lucey, 2010; Baur and McDermott, 2010; Ghabri *et al.*, 2022; Wang *et al.*, 2022; Abdullah, 2023; Wang *et al.*, 2023a).

4. EMPIRICAL METHODOLOGY

Building on the definitions of Baur and Lucey (2010) and based on the works of Rizvi *et al.* (2022) and Wang *et al.* (2022), we aim to investigate the hedging and safe haven capabilities of gold and Bitcoin against the G7 stock market indices. This will involve examining the connectedness among these assets during the COVID-19 pandemic, the Russia-Ukraine military conflict, and the Silicon Valley Bank crisis. In this case, we applied the novel quantile vector autoregression (Q-VAR) methodology[4] of Chatziantoniou *et al.* (2021), which is established based on the pioneering works of Diebold and Yilmaz (2009, 2012, 2014) in their series of papers and further developed by Ando Ando *et al.* (2022)[5]. This methodology is used in our work to examine the quantile propagation mechanism and, consequently, to inspect the asymmetric dynamic relationships and spillovers among Bitcoin, gold, and the G7 stock market indices and reevaluate and confirm the concept of a safe haven investment. For instance, the works of Baur and McDermott (2010) and Baur and Lucey (2010) that examine the relationships and causality between gold and stock markets primarily rely on traditional time series techniques (such as vector autoregression (VAR) and Granger causality tests) and linear modeling approaches that do not explicitly consider potential nonlinear or asymmetric effects. Compared to these methodologies, the Q-VAR methodology offers a more flexible and comprehensive framework for capturing the dynamic and potentially nonlinear relationships between assets, making it well-suited for analyzing complex and evolving market dynamics.

Table no. 1 – Descriptive statistics

	Bitcoin	*Gold*	*SP500*	*FTSE*	*Nikkei*	*DAX.40*	*CAC.40*	*FTSE.MIB*	*S.P.TSX*
Mean	0.002**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Variance	0.002***	1.38E-05***	2.12E-05***	0.006***	2.84E-05***	3.00E-05 ***	2.93E-05***	4.05E-05***	1.87E-05***
Skewness	-0.840***	-0.248***	-0.868***	-0.254***	-0.169***	-0.721***	-1.028***	-1.879***	-1.829***
Ex.Kurtosis	10.984***	3.343***	16.779***	937.694***	5.471***	12.835***	13.428***	21.913***	45.691***
JB	10052.145***	929.994***	23166.883***	71587310.838***	2446.379***	13582.239***	15023.690***	40244.760***	171062.109***
ERS	-4.622***	-15.410***	-12.406***	-19.574***	-17.636***	-19.565***	-18.035***	-20.508***	-17.839***
Q(20)	11.876	4.305	11.402	0.320	10.498	12.405	10.927	12.491	8.108
Q2(20)	9.776	9.730	3.862	0.022	16.477*	19.428**	15.553*	7.995	1.346

Note: ***, **, and * means significant at the 1%, 5%, and 10% level of significance, respectively. JB refers to the Jarque Bera normality test. ERS refers to Elliott, Rothenberg and Stock unit root test. Q and Q2, respectively, refer the return and squared return sequences of the Ljung-Box text.

Table no. 2 – Kendall correlation matrix between Bitcoin, gold, and the G7 stock indices

kendall	*Bitcoin*	*Gold*	*SP500*	*FTSE*	*Nikkei*	*DAX.40*	*CAC.40*	*FTSE.MIB*	*S.P.TSX*
Bitcoin	1.000***	0.063***	0.104***	0.047***	-0.001	0.064***	0.063***	0.063***	0.112***
Gold	0.063***	1.000***	-0.006	-0.021	-0.024	-0.052***	-0.049***	-0.039***	0.070***
SP500	0.104***	-0.006	1.000***	0.285***	0.094***	0.325***	0.325***	0.296***	0.461***
FTSE	0.047***	-0.021	0.285***	1.000***	0.127***	0.480***	0.521***	0.431***	0.320***
Nikkei	-0.001	-0.024	0.094***	0.127***	1.000***	0.141***	0.138***	0.108***	0.109***
DAX.40	0.064***	-0.052***	0.325***	0.480***	0.141***	1.000***	0.731***	0.623***	0.373***
CAC.40	0.063***	-0.049***	0.325***	0.521***	0.138***	0.731***	1.000***	0.643***	0.393***
FTSE.MIB	0.063***	-0.039***	0.296***	0.431***	0.108***	0.623***	0.643***	1.000***	0.364***
S.P.TSX	0.112***	0.070***	0.461***	0.320***	0.109***	0.373***	0.393***	0.364***	1.000***

Note: ***, **, and * means significant at the 1%, 5%, and 10% level of significance, respectively.

The quantile vector autoregression (Q-VAR) approach involve the utilization of a generalized VAR approach that incorporates dynamic analysis using rolling-window methodology (Diebold and Yilmaz, 2009). Hence, the variance decomposition of forecast errors elucidates the impact of structural shocks on the returns of individual variables within a network. Elevated total connectedness values indicate robust interdependencies among network variables, thereby indicating the presence of a contagion effect, which is assessed through directional connectedness measures.

Quantile interconnectedness examines the association between variables in the presence of profound structural perturbations, encompassing both upper and lower quantiles. Accordingly, it detects the presence of robust or weak interconnectedness given the magnitude of the shock, subsequently offering insights into the anticipation of whether heightened connectedness would be accompanied by positive or negative returns. The Q-VAR approach is developed as follows.

$$y_t = \mu_t(\tau) + \Phi_1(\tau)y_{t-1} + \Phi_2(\tau)y_{t-2} + \cdots + \Phi_p(\tau)y_{t-p}\mu_t(\tau) \quad (1)$$

In this context, y_t and y_{t-i} (i = 1,…, p) are vectors representing endogenous variables, each possessing dimensions of $N \times 1$. The parameter τ falls within the interval [0, 1] and signifies the quantile of pair return-volume, while p denotes the lag duration of the Q-VAR approach. $\boldsymbol{\mu}(\tau)$ represents an $N\times1$ dimensional vector indicating the conditional average, Φ_j (τ) corresponds to an $N \times N$ dimensional matrix comprising Q-VAR coefficients, and μ_t (τ) is an $N \times 1$ dimensional error vector with an $N\times N$ dimensional error variance-covariance matrix denoted as $\boldsymbol{\Sigma}(\tau)$. the QVAR (p) model can be transformed into its quantile vector moving average representation, denoted as QVMA (∞) by applying Wold's theorem such that:

$$y_t = \mu_t(\tau) + \sum_{j=1}^{p} \Phi_j(\tau)y_{t-j} + u_t(\tau) = \mu(\tau) + \sum_{i=0}^{\infty} \Psi_i(\tau)u_{t-i} \quad (2)$$

Subsequently, we compute the H-step-ahead Generalized Forecast Error Variance Decomposition (GFEVD) based on the works of Koop *et al.* (1996) and Pesaran and Shin (1998) which assesses the impact of a disturbance in series j on series i. It can be presented as follows:

$$\theta_{ij}^{g}(H) = \frac{\sum(\tau)_{jj}^{-1}\sum_{h=0}^{H-1}(e_i' A_h(\tau)\sum(\tau)e_j)2}{\sum_{h=0}^{H-1}(e_i' A_h(\tau)\sum(\tau)A_h'(\tau)e_i)} \quad (2)$$

$$\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{k}\theta_{ij}^{g}(H)}$$

e_i is a selection vector that takes on a value of one for the ith element and zero for all other elements. Since the row summing of the decomposed variance matrix is not always equivalent to 1, each item in the matrix $\tilde{\theta}_{ij}^{g}(H)$ gets normalized by the row sum, and therefore the row sum will always equal 1. Normalization results in the emergence of the two subsequent equations:

$$\sum_{i=1}^{N} \tilde{\theta}_{ij}^{g}(H) = 1 \ \ and \sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(H) = N$$

Hence, each row of $\tilde{\theta}_{ij}^{g}$ sums to one, illustrating how a disturbance in sequence i has influenced both that sequence and all other sequences j.

Furthermore, we compute the measures of interconnectedness. Initially, we calculate the net pairwise connectivity in the following manner:

$$NPC_{ij}(\mathrm{H}) = \tilde{\theta}_{ij}^{g}(\mathrm{H}) - \tilde{\theta}_{ji}^{g}(\mathrm{H}) \tag{3}$$

If $NPC_{ij}(\mathrm{H}) > 0$ ($NPC_{ij}(\mathrm{H}) < 0$), it indicates that series i exerts a stronger (weaker) impact on series j compared to the reverse influence.

To examine the extent to which a disturbance in variable i influences all other variables j, we calculate the total directional connectedness TO others as follows:

$$TO_i(H) = C_{i\rightarrow j}^{g}(H) = \sum_{i=1, i\neq j}^{N} \tilde{\theta}_{ij}^{g}(H) \tag{4}$$

To examine the extent to which a variable i is influenced by disturbances in all other variables j, we calculate the total directional connectedness FROM others as follows:

$$FROM_i(H) = C_{i\leftarrow j}^{g}(H) = \sum_{i=1, i\neq j}^{N} \tilde{\theta}_{ij}^{g}(H) \tag{5}$$

The disparity between the total directional connectedness TO other variables and the total directional connectedness FROM other variables yields the net total directional connectedness, which can be interpreted as the net impact that variable i exerts on the examined network.

$$\begin{aligned} NET_i(H) &= TO_i(H) - FROM_i(H) \\ C_i^{g}(H) &= C_{i\rightarrow j}^{g}(H) - C_{i\leftarrow j}^{g}(H) \end{aligned} \tag{6}$$

The final measure of interconnectivity is the modified total connectedness index (TCI) developed by Chatziantoniou and Gabauer (2021) and described in Gabauer (2021), which evaluates the extent of network interconnectivity, can be calculated as follows:

$$TCI(H) = N - 1 \sum_{i=1}^{N} TO_i(H) = N - 1\, FROM_i(H) \tag{7}$$

This measure is frequently employed as a proxy for market risk, as a greater TCI value indicates a heightened level of network interdependence.

5. EMPIRICAL RESULTS

5.1 Median Q-VAR static and dynamic connectedness results

5.1.1 Static examination of the interconnectivity framework between Gold, Bitcoin, and the G7 stock market indices at the median quantile

Table no. 3 compiles the findings of the static interconnectedness metrics pertaining to every G7 stock index, Bitcoin, and gold. These results arise from the median Q-VAR model, which was employed to investigate the interconnectedness of risk and the transmission of shocks. The overall interconnectivity (TCI) within this framework is 63.61%, suggesting the existence of a strong correlation between digital and financial assets. This signifies the presence of contagion effects within this structure, implying that both Bitcoin and gold are not separated from the financial system (Ghorbel and Jeribi, 2021; Ghorbel *et al.*, 2022a; Ghorbel *et al.*, 2022b; Ali *et al.*, 2023; Béjaoui *et al.*, 2023). The mean impact of the G7 stock market indices is 67.11%, whereas the effects of Bitcoin and gold are above 19%. Indeed, the substantial mean value of the equity indices highlights greater shock transmissions to the system originating from global stock markets in comparison to those originating from the cryptocurrency and gold markets as contributors to market fluctuations.

The examination of net connectivity reveals that Bitcoin contributes 19.08% to the overall system's fluctuations, whereas the system itself is responsible for 26.58% of the fluctuations observed in Bitcoin returns. This suggests that Bitcoin serves as a substantial recipient of shocks, with a relatively smaller role in transmitting shocks to other entities. The same result is also observed with gold, which transmits 19.96% and receives 33.45% from the system.

Indeed, when considering the stock indices, the CAC 40 emerges as the most substantial shock contributor to the overall system connectedness, accounting for 92.97%. Simultaneously, it also receives the highest share from the system, tallying at 73.28%, thereby resulting in favorable net connectedness with respect to the system, standing at 19.69%. Conversely, the NIKKEI index ranks as the least significant shock contributor to the system, contributing merely 19.32%. In contrast, it receives approximately 53% of the system's contribution. As a result, the NIKKEI serves as a substantial recipient of shocks and exhibits a greater increase in spillovers compared to other entities.

The static interconnectedness findings show that Bitcoin and gold are the least shock receivers from the system while at the same time, they play a smaller role in transmitting shocks to the system. This can explain their use as hedging or safe haven tools for the different portfolio combinations (Wang *et al.*, 2022). On the other hand, the G7 stock market indices are considered the most shock receivers from the system while at the same time, they are considered the most contributors, surging the need to hedge their related risk. In fact, the static connectedness analyses are considered general to formulate meaningful and significant conclusions. These results will be further checked through the forthcoming examination of the dynamic interconnectedness.

Table no. 3 – Static interconnectedness between Bitcoin, gold, and the G7 stocks

	Bitcoin	*Gold*	*SP500*	*FTSE*	*Nikkei*	*DAX.40*	*CAC.40*	*FTSE.MIB*	*S.P.TSX*	*FROM*
Bitcoin	73.42	3.31	4.93	2.68	2.09	3.10	3.05	2.98	4.44	26.58
Gold	3.52	66.55	4.77	3.21	2.44	5.32	4.99	4.53	4.67	33.45
SP500	3.08	2.44	43.09	7.18	2.48	9.37	9.19	8.06	15.11	56.91
FTSE	1.94	1.63	8.43	38.71	2.58	12.93	14.64	11.52	7.63	61.29
Nikkei	2.67	3.32	9.89	5.45	47.01	8.63	8.55	7.17	7.32	52.99
DAX.40	1.63	2.33	7.66	11.06	2.49	27.76	21.39	17.62	8.07	72.24
CAC.40	1.53	2.22	7.44	12.24	2.59	20.67	26.72	17.88	8.70	73.28
FTSE.MIB	1.78	2.20	6.81	10.40	2.15	18.74	19.73	30.08	8.10	69.92
S.P.TSX	2.93	2.53	14.85	7.98	2.48	10.22	11.42	9.76	37.82	62.18
TO	19.08	19.96	64.78	60.20	19.32	88.98	92.97	79.51	64.05	508.84
Inc.Own	92.50	86.51	107.88	98.90	66.32	116.73	119.69	109.59	101.87	cTCI/TCI
NET	-7.50	-13.49	7.88	-1.10	-33.68	16.73	19.69	9.59	1.87	63.61/56.54
NPT	2.00	1.00	4.00	4.00	0.00	7.00	8.00	6.00	4.00	

5.1.2 Dynamic examination of the interconnectivity framework between Gold, Bitcoin, and the G7 stock market indices at the median quantile

Even though the examination of the entire dataset effectively described interconnectedness from a static point of view, the transformations that transpired within the financial market amid the spread of the COVID-19 pandemic, the Russia-Ukraine conflict, and Silicon Valley Bank collapse demand a more precise and dynamic examination. In this case, we applied Diebold and Yilmaz (2009) rolling-window methodology to expand the static interconnectedness framework encompassing the entire dataset and examine the dynamic time-varying interconnectedness during different market conditions. In fact, the occurrences of the COVID-19 pandemic, the Russian-Ukrainian military conflict, and the recent American banking crisis significantly impacted worldwide stock market indices and the performance of different safe-haven assets (i.e., gold and cryptocurrency), necessitating a deep examination of the repercussions caused by these crises.

For enhanced comprehension, we graph the overall interconnectedness across time segments before and during the COVID-19 pandemic, the Russia-Ukraine conflict, and the SVB collapse, aiming to assess its tendency and different variations. Figure no. 1 illustrates the total dynamic connectedness throughout the sample period to gain a deeper understanding of the dynamic market risk. From this figure, we can identify the three shocks related to the COVID-19 pandemic, the Russian-Ukrainian war, and the SVB failure. In fact, it becomes apparent that the interconnectedness within this framework exhibits temporal variability, ranging from approximately 50% before the outbreak to a heightened level of 78% during the COVID-19 outbreak. This level then decreases to a relatively lower value of 62% during the war and further declines to 58% during the banking crisis. It is worth noting that the interconnectedness between Bitcoin, gold, and the G7 stock indices witnessed its highest peak during the COVID-19 pandemic. This surge may be explained by the contagion measures adopted by different countries, such as city and border closures, curfews, etc., and the negative

response of digital and financial assets to this health crisis (Jeribi and Snene-Manzli, 2020; Zhang *et al.*, 2020; Yarovaya *et al.*, 2021; D'Amato *et al.*, 2022; Selmi, 2022). After that, the interconnectedness returned to average levels until the occurrence of the Russia-Ukraine war and the banking crisis.

In conclusion, the aforementioned findings suggest that significant unforeseeable events could heighten the risk transmission connections among Bitcoin, gold, and the G7 equity markets, amplifying the overall spillover effects between potential safe-haven assets and stock markets. As global economic interconnection deepens, and as information technology continually advances, the exchange of information and risks between diverse worldwide markets is becoming more robust. Therefore, when a severe risk event occurs within a market, its detrimental consequences swiftly spread to other markets via multiple ways like trading, speculations, and investments, thereby strengthening the interconnectedness among potential safe-haven assets and stock markets.

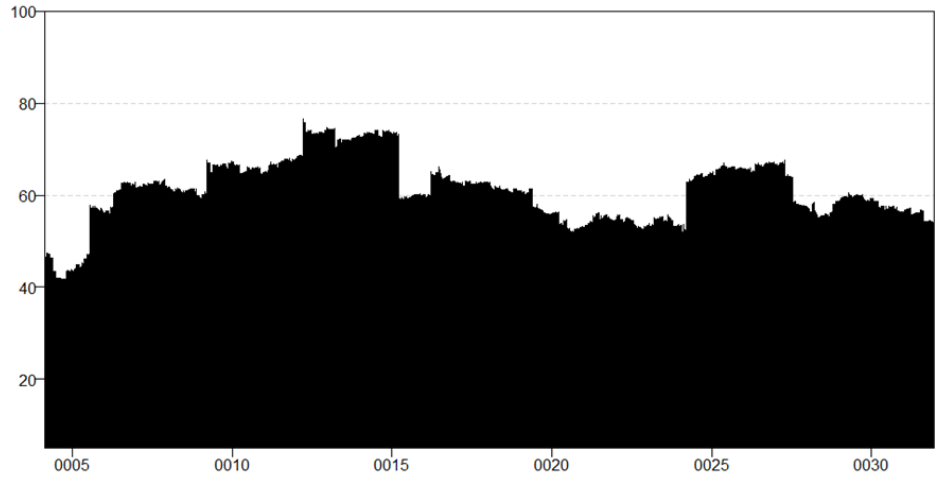

Figure no. 1 – Total dynamic connectedness

From Figure no. 2, we depict the dynamic total directional connectedness emanating from each of the seven stocks, Bitcoin, and gold towards the rest (i.e., directional influence or spillover from one asset TO others). From this figure, we can observe that the TO-spillover from Bitcoin was low and did not exceed 15% before the COVID-19 pandemic. However, it fluctuated between 45% and 50% during this health crisis. During the Russia-Ukraine conflict period and the SVB crisis, the TO-spillover from Bitcoin returned to a low degree of about 10%. This reduced transmission of shocks can suggest decreased interdependencies or associations between Bitcoin and other assets, potentially leading to a reduction in systemic risk within a portfolio, making Bitcoin an effective safe haven during the war (Tut, 2022; Kayral *et al.*, 2023) and the banking crisis (Jin and Tian, 2023).

The TO-spillover from gold was the lowest before and during the three crises, as it did not exceed 10%. This suggests its low association with other assets and its possible use as a perfect hedge during normal times and a safe haven tool during periods of crisis (Baur and Lucey, 2010; Baur and McDermott, 2010). This finding indicates that gold outperforms

Bitcoin as a hedging and a safe haven asset, confirming the findings of Ghabri *et al.* (2022); Kayral *et al.* (2023).

In regard to the G7 stock market indices, the TO-interconnection degrees exhibit notable values throughout the entire period and sometimes exceed 100%, except for the NIKKEI index. The most elevated levels of spillover are observed within the G7 stock markets (excluding the NIKKEI), indicating their high responsiveness to disturbances compared to cryptocurrencies and gold. The G7 equity market indices are considered "risk-on" investments and typically undergo increased price fluctuations during the COVID-19 health crisis, the ongoing Russia-Ukraine military conflict, and the SVB crisis, highlighting the need to hedge against their associated risks (Ghorbel *et al.*, 2022a; Fakhfekh *et al.*, 2023).

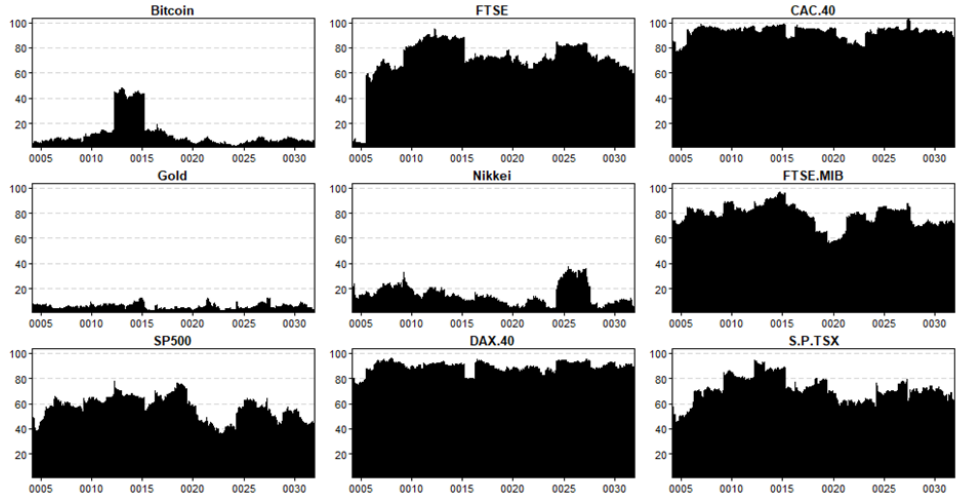

Figure no. 2 – Total directional connectedness– TO the system

Figure no. 3 illustrates the dynamic total directional connectedness originating from the system towards each of Bitcoin, gold, and the G7 stock markets (i.e., directional influence FROM others to one asset). It is noteworthy that the spillover FROM the global system to digital and financial assets displays substantial fluctuations, particularly evident amid the COVID-19 pandemic and the timeframe of the Russian-Ukrainian conflict. It is also evident during the banking crisis for the G7 stock market indices. From this figure, we can see that gold is the least shock receiver during the entire period. Also, the spillover FROM the global system to Bitcoin was more pronounced during the COVID-19 pandemic than during the war. As for the G7 stock market indices, they are considered the most shock receivers from the system, with a level of about 80% in most cases. This might be explained by the fact that the G7 stocks are regarded as the most developed economies and among the most likely to respond dramatically to severe market situations (Ghorbel *et al.*, 2022a; Ghorbel *et al.*, 2022b; Fakhfekh *et al.*, 2023) and due to their elevated degree of integration and interconnection with the global economy (Pandey *et al.*, 2023).

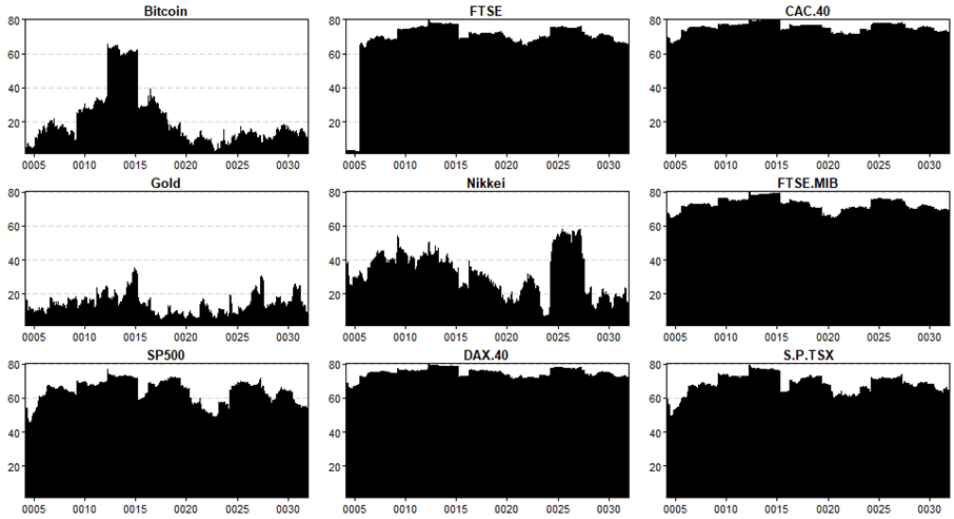

Figure no. 3 – Total directional connectedness– FROM the system

Figure no. 4 illustrates the total net directional connectedness which corresponds to the difference between the TO-connectivity and the FROM-connectivity. According to Rizvi *et al.* (2022); Wang *et al.* (2022), when an asset has a negative value, it implies not just the asset's function as a shock receiver but also its role as a hedging mean and thus as a safe haven during times of crises. Concerning the two recognized safe haven assets, it is evident that the values for Bitcoin and gold remains (almost) consistently negative throughout the entire period. Both assets are considered net receivers of shocks, with a substantial increase in their net reception during the three crises. Bitcoin is considered the most significant shock receiver, particularly during the COVID-19 pandemic, while gold outperforms Bitcoin during the war and the banking crisis. This suggests their hedging ability during normal times and their safe haven ability against the G7 stock market indices during periods of crises (Rizvi *et al.*, 2022; Wang *et al.*, 2022) with gold being the most resilient safe haven asset. These results align with Ghabri *et al.* (2022); Abdullah (2023); Widjaja and Havidz (2024), who found that gold is a more suitable hedging and safe haven asset than Bitcoin, and its inclusion within a stock market portfolio leads to a reduction in overall portfolio risk. The findings are also consistent with Azmi *et al.* (2023); Baur (2023), who assert that gold acts as a safe haven during the SVB failure. The results further support those of Abdelmalek and Benlagha (2023), who discovered that Bitcoin is a hedge before the COVID-19 pandemic and a safe haven during this health crisis.

Among the G7 stock market indices, the Japanese stock index (NIKKEI) is the most significant net receiver of shocks during the three crises, followed by the American stock index (S&P500). Typically, investors aim to hedge the risks associated with their stock market indices. However, in this case, NIKKEI and the S&P500 present the possibility of serving as assets for risk diversification. On the other hand, the French (CAC.40) and German (DAX.40) stock market indices are the most significant net transmitters of shocks. As for the rest of the G7 stock market indices (FTSE, FTSE.MIB, and SP.TSX), they are considered mostly net transmitters of shocks during the COVID-19 pandemic. Besides, we note that the net

transmission of shocks of these stock markets exhibited a modest decline after the COVID-19 pandemic followed by a subsequent resurgence coinciding with the occurrence of the Russian-Ukrainian military conflict and the SVB collapse. This signifies a noteworthy alteration in their attributes owing to instability.

In summary, it can be inferred that the degree of interconnectedness among these digital and financial assets is contingent upon the extent of economic and financial disruptions, as exemplified by the transmission dynamics of the COVID-19 pandemic and the development of the Russia-Ukraine conflict and the SVB crisis. It is also worth noting that the repercussions of the COVID-19 pandemic and the war are much stronger than the American banking crisis. In fact, the contagion among these assets during the SVB crisis was of brief duration, as the collapse exhibited relatively restricted effects in other markets in comparison to the banking sector (Akhtaruzzaman *et al.*, 2023).

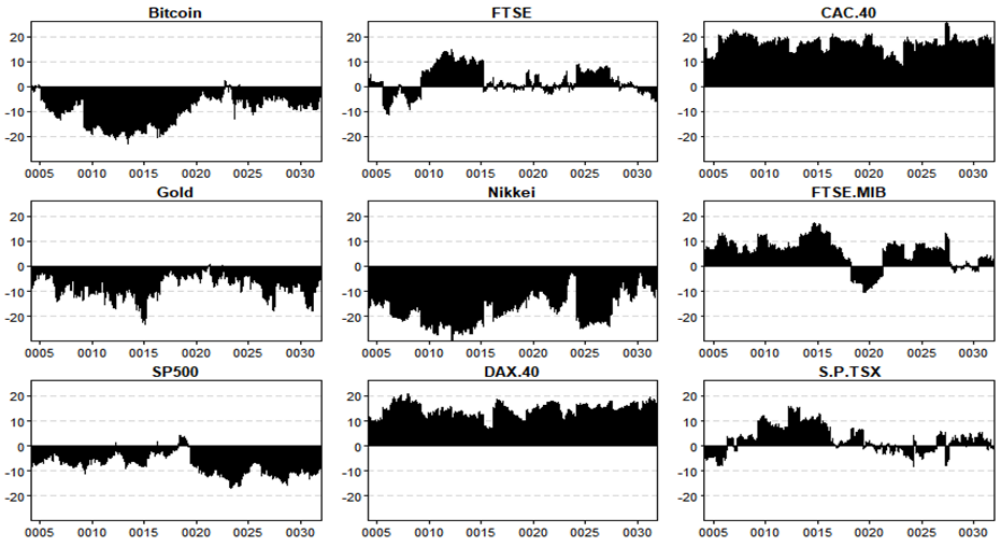

Figure no. 4 – Total net directional connectedness – (net = to-from)

Subsequently, we formulate the directional connectivity framework using the net pairwise interconnection in Figure no. 5 through a graphical representation depicting the interconnections among each stock index, Bitcoin, and gold over the entire dataset. Each of these entities is designated as a node that represents Bitcoin, gold, and one of the G7 stocks, and a directional connection from one entity to another is established using arrows. The nodes with the golden-yellow color are the net shock receivers; whereas, the nodes with the blue color are the net shock transmitters. This also can be observed by the number of arrows received and transmitted by each node. From Figure no. 5, it becomes evident that the Japanese stock index (NIKKEI) stands as the foremost recipient of shocks emanating from the overall system followed by the American stock index (S&P500) and Bitcoin, while gold is the least shock receiver from the system. This is also evidenced by the thickness and number of the arrows received by these assets. In fact, gold is not only the least receiver of shocks (receives only from the SP.TSX stock index), but it is also the least transmitter of shocks and

it is uncorrelated with Bitcoin and the rest of the G7 stock indices, implying its plausible role as a safe haven tool against uncertainties derived from these assets during the COVID-19 pandemic, the Russian-Ukrainian military conflict, and the banking crisis.

Furthermore, DAX.40 and CAC.40 are the most shock transmitters followed by FTSE, FTSE.MIB, and SP.TSX stock indices. The G7 stock market indices also exhibit a strong correlation with each other which can be evidenced by the thickness of their connecting arrows whether they are receivers or transmitters. This result surges the need for uncorrelated assets (such as gold) to safeguard against the risk related to stock markets (Jeribi and Snene-Manzli, 2020; Ghorbel *et al.*, 2022a).

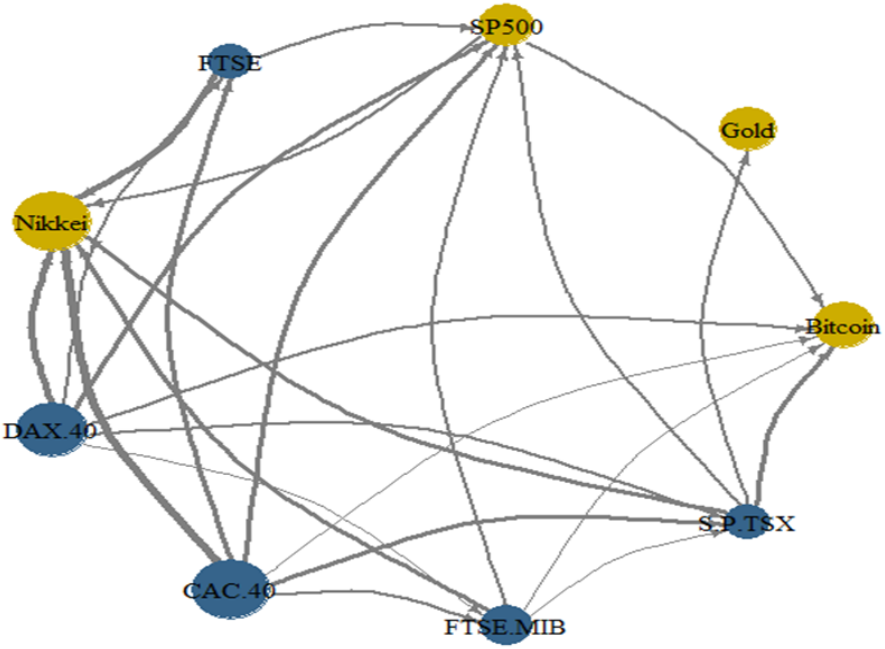

Figure no. 5 – Net pairwise directional connectivity framework between Gold, Bitcoin, and the G7 stocks

5.2 Total and net dynamic connectedness between Gold, Bitcoin, and the G7 stock market indices across different quantiles

Finally, to check the robustness of our results and better understand market dynamics, we concentrate on the connectedness across different quantiles. Figure no. 6 exemplifies the outcomes pertaining to the total dynamic connectedness among Bitcoin, gold, and the G7 stock market indices across different quantiles. The horizontal axis depicts the timeline, while the vertical axis illustrates quantiles, which span from 0.05 to 0.95 with increments of 1%. The warmer hues depicted on the graph are indicative of elevated degrees of interconnectedness. It is clear that the interconnection exhibits considerable robustness for both significantly negative shocks (below the 20% quantile) and significantly positive shocks (exceeding the 80% quantile). In other words, the influence seems to be symmetrical.

Moreover, the 50% quantile aligns with the overall mean level of interconnectedness throughout the entire timeframe, displaying noteworthy values spanning the onset of the COVID-19 pandemic to the outbreak of the Russian-Ukrainian military conflict and the SVB crisis. As for the period before the announcement of the pandemic (period of stability), it is characterized by low interconnectedness. This finding suggests that the level of interconnectedness is profoundly reliant on significant occurrences or incidents (Blanka and Karolina, 2020).

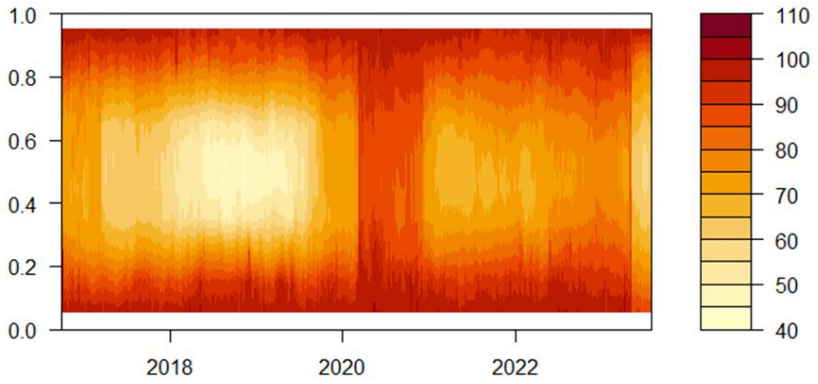

Figure no. 6 – Total dynamic connectedness between Bitcoin, gold, and the G7 stock market indices across different quantiles

Next, we present the total net directional connectedness of all the assets across different quantiles in Figures no. 7-15. Red color shades (higher quantiles) on these figures indicate that the asset is a net transmitter of shocks. Whereas, blue color shades (lower quantiles) indicate that the asset is a net receiver of shocks. Figures no. 7 and no. 8, respectively, illustrate the net directional connectedness for gold and Bitcoin. We can see that both assets act as net receivers of shocks during the three crises, with gold being the most important shock receiver, especially during the COVID-19 pandemic. These findings confirm the above-mentioned results of the net directional connectedness based on the median Q-VAR approach. In fact, the negative correlations between gold (respectively, Bitcoin) and the system became more robust during the crises periods (blue color shades). Thus, gold and Bitcoin are considered hedging assets during normal times and strong safe haven assets during the three crises (Rizvi *et al.*, 2022; Wang *et al.*, 2022) with gold being the strongest safe haven asset.

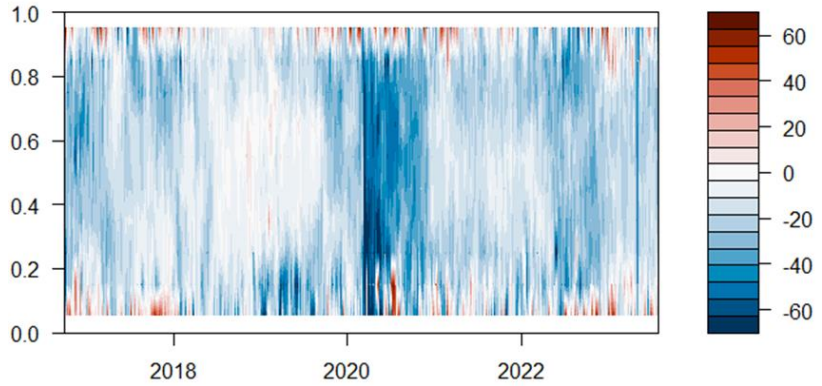

Figure no. 7 – Total net directional connectedness for Gold across different quantiles

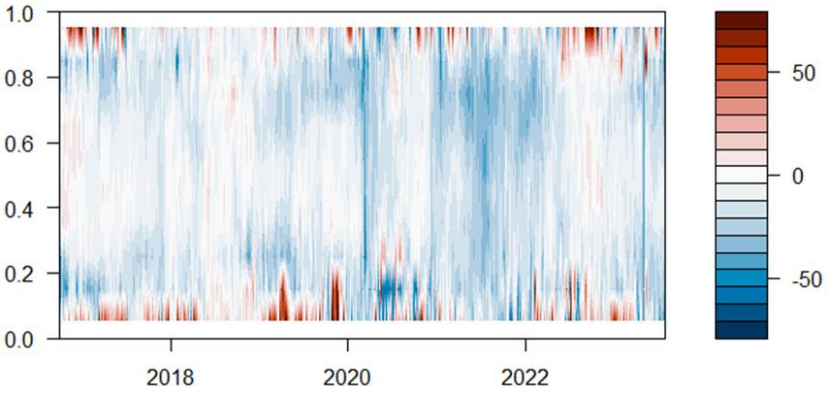

Figure no. 8 – Total net directional connectedness for Bitcoin across different quantiles

As for the G7 stock market indices, we can observe that the SP.TSX, FTSE.MIB, CAC.40, and DAX.40 stock market indices (Figures no. 9-12) shifted from being net receivers of shocks before the announcement of the COVID-19 pandemic to being net transmitters of shocks during the pandemic and the Russia-Ukraine war, and then to becoming very weak net receivers of shocks during the SVB crisis. This indicates their high vulnerability to risks and losses when market conditions deteriorate. As for the FTSE stock index (Figure no. 13), it predominantly acted as a net transmitter of shocks, especially during the American banking crisis.

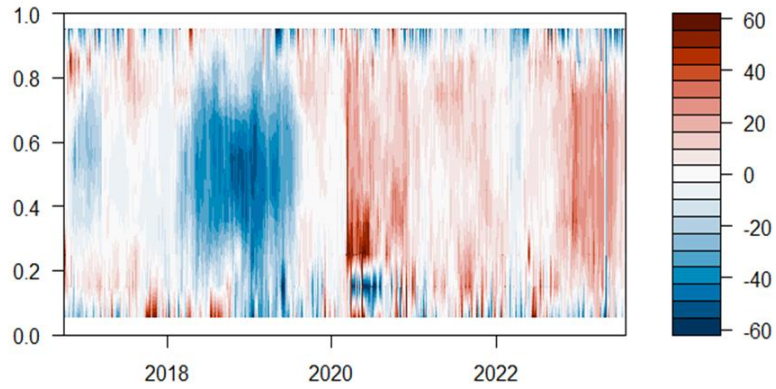

Figure no. 9 – Total net directional connectedness for the Canadian stock index across different quantiles (S.P.TSX)

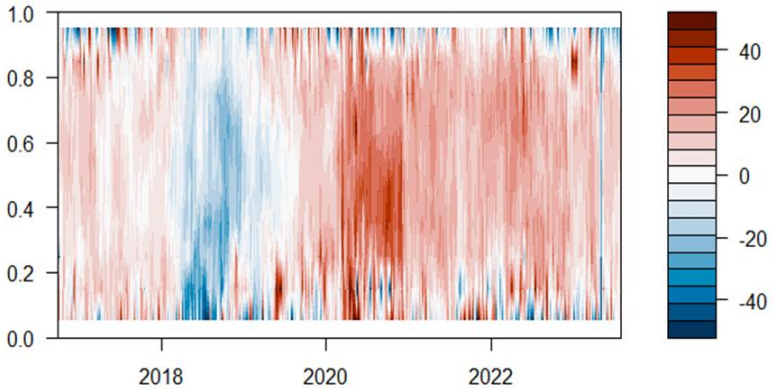

Figure no. 10 – Total net directional connectedness for the Italian stock index across different quantiles (FTSE.MIB)

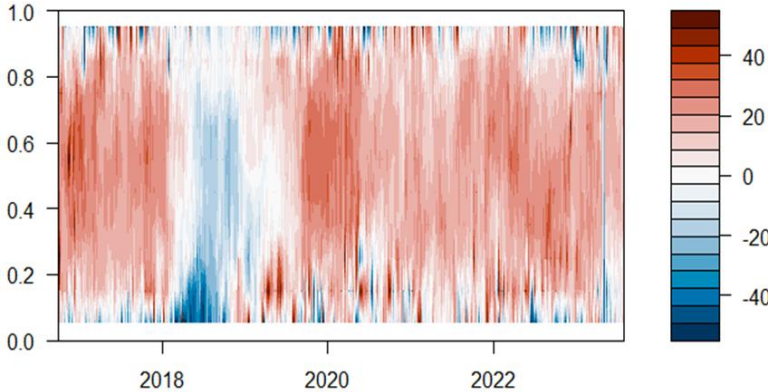

Figure no. 11 – Total net directional connectedness for the French stock index across different quantiles (CAC.40)

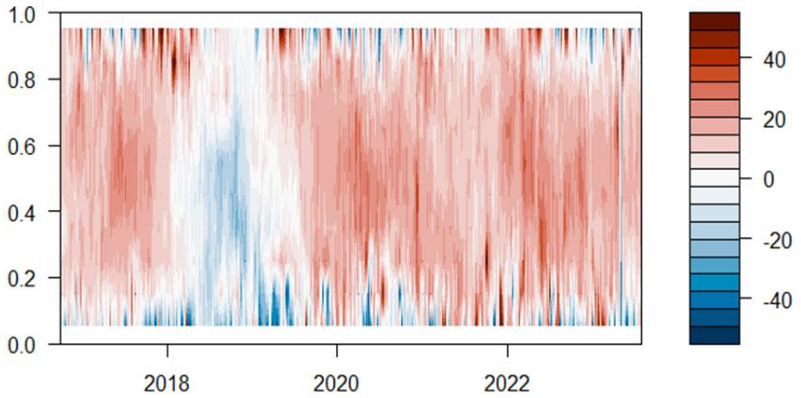

Figure no. 12 – Total net directional connectedness for the German stock index across different quantiles (DAX.40)

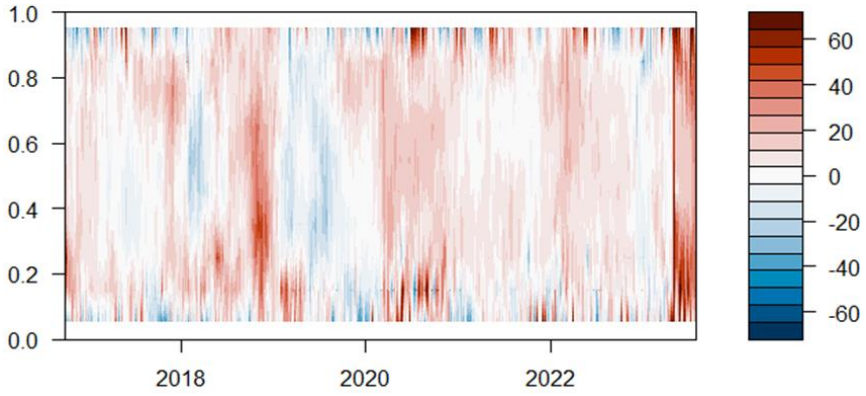

Figure no. 13 – Total net directional connectedness for the British stock index across different quantiles (FTSE)

Moreover, Figure no. 14 shows that the Japanese stock market index (NIKKEI) transitioned from being a net transmitter of shocks before the outbreak to becoming a strong net receiver of shocks during the outbreak, and an even more pronounced net receiver during the war and the banking crisis. This result implies that NIKKEI's role changed from being a risky asset before the COVID-19 crisis to becoming a strong risk diversifier during the three crises. Also, Figure no. 15 illustrates that the American stock market index (S&P500) served as a significant transmitter of shocks before the COVID-19 pandemic, and it maintained this role throughout the period, albeit with lower degrees, indicating its failure as a diversifier during the entire period.

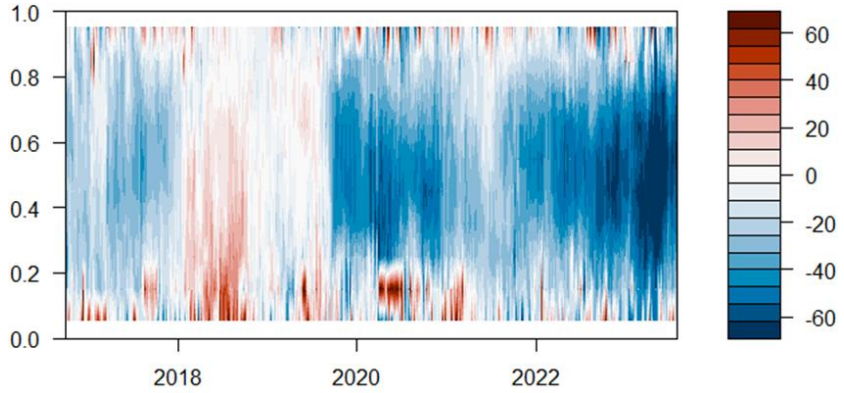

Figure no. 14 – Total net directional connectedness for the Japanese stock index across different quantiles (Nikkei)

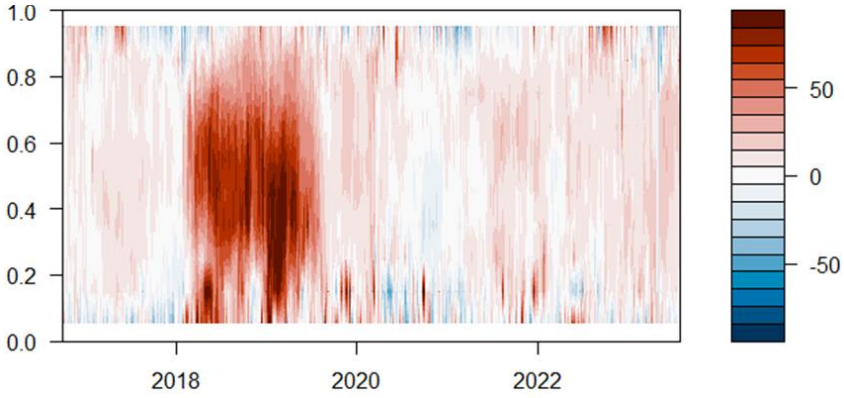

Figure no. 15 – Total net directional connectedness for the American stock index across different quantiles (SP500)

6. CONCLUSION AND DISCUSSION

The global financial markets have been significantly shaken by the COVID-19 pandemic, the ongoing Russo-Ukrainian conflict, and the recent American Silicon Valley Bank (SVB) crisis. This turmoil has disrupted investor confidence in financial markets, prompting the need to explore alternative investment options that can withstand these crises. In this paper, we investigate the hedging and safe haven abilities of gold and Bitcoin against the G7 stock market indices by examining the connectedness among these assets during the COVID-19 pandemic, the Russia-Ukraine war, and the SVB collapse. To do so, we applied the novel Q-VAR approach of Chatziantoniou *et al.* (2021) which is based on the works Diebold and Yilmaz (2009, 2012, 2014) and further developed by Ando *et al.* (2022).

At the median quantile, the results show that the total connectedness (TCI) is 63.61%, suggesting the existence of a strong correlation between digital and financial assets and the presence of contagion effects. In fact, the total dynamic connectedness results reveal that spillover varies over time, starting at around 50% before the outbreak, increasing to 78%

during COVID-19, relatively decreasing to 62% during the war, and further reducing to 58% during the banking crisis. Also, the total net directional connectedness results reveal that Bitcoin and gold are net receivers of shocks with a substantial increase in their net reception during the three crises. Bitcoin is considered the most net receiver of shocks in comparison to gold, particularly during the COVID-19 pandemic. Whereas, gold outperforms Bitcoin during the war and the banking crisis. This suggests their hedging ability during normal times and their safe haven ability against the G7 stock market indices during periods of crises, with gold being the most significant safe haven asset (Cheema *et al.*, 2020; Ghabri *et al.*, 2022; Ghorbel *et al.*, 2022b; Abdullah, 2023).

Among the G7 stock market indices, the Japanese stock index (NIKKEI) is the most significant net receiver of shocks during the three crises, followed by the American stock index (S&P500), suggesting their possible use as risk diversifiers. As for the rest of the G7 stock market indices, they are considered mostly net transmitters of shocks during the entire period, with the French (CAC 40) and German (DAX 40) stock market indices being the most significant net transmitters of shocks. These results are also confirmed by the net pairwise directional connectivity between gold, Bitcoin, and the G7 stocks using nodes. In fact, gold is found to be the least transmitter and receiver of shocks, confirming that it is the most resilient safe haven asset in our study.

Afterward, to assess the robustness of our results, we examined the connectedness and transmission of shocks across different quantiles. The findings are consistent with those observed at the median quantile, except in the case of the S&P500. Our results indicate that the degree of interconnectedness among these digital and financial assets is contingent upon the extent of economic and financial disruptions observed. It is also worth noting that the repercussions of the COVID-19 pandemic and the war are much stronger than those of the American banking crisis. In fact, the contagion among digital and financial assets during the SVB crisis was of brief duration, as the collapse exhibited relatively restricted effects in other markets in comparison to the banking sector (Akhtaruzzaman *et al.*, 2023).

Our results have policy ramifications that could be advantageous for stock investors in developed countries and guide them in making various choices concerning investments during turbulent times. By highlighting the significance of gold and Bitcoin as reliable safe-haven assets, our research provides investors with crucial insights into constructing resilient and diversified investment portfolios. Policymakers may consider utilizing these insights to develop frameworks and regulations that encourage the inclusion of these alternative assets into investment strategies, thus enhancing portfolio resilience and improving risk management practices. Moreover, our findings highlight the significance of incorporating dynamic market risk considerations into investment decision-making. This emphasizes the need for policymakers to prioritize efforts directed at enhancing investor understanding and awareness of how safe-haven assets can help mitigate market uncertainties. Additionally, policymakers may explore avenues for fostering innovation and infrastructure development within the digital asset space to facilitate greater accessibility and adoption of Bitcoin and other cryptocurrencies as viable investment options. On the other hand, investors in stocks within developing and emerging economies find themselves compelled to turn to gold as a safe haven asset, primarily because Bitcoin lacks this particular attribute within these countries (see, for instance, Jeribi *et al.* (2020); Widjaja and Havidz (2024). This situation is further exacerbated by the diverse regulatory measures imposed by the governments of some

of these nations, which inhibit the operation of Bitcoin exchanges and the associated trading activities.

Furthermore, given that the SVB collapse has a more significant impact on the banking sector and a limited effect on stock markets, this situation offers an opportunity for future research to conduct a comprehensive analysis of the crisis's influence on bank stocks. It is also crucial to assess whether Bitcoin and gold can act as safe havens for these stocks during the SVB collapse.

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Notes

[1] https://www.bbc.com/news/business-51829852.

[2] https://www.nytimes.com/2023/03/10/business/stock-market-jobs-report.html

[3] https://www.telegraph.co.uk/business/2023/03/10/ftse-100-markets-live-news-uk-gdp-economy-budget/#:~:text=US%20regulators%20last%20night%20took,down%201.67pc%20in%20London.

[4]The extension of the numerous identification strategies proposed in the VAR literature (Ramey, 2016) to the QVAR context constitutes an important area of research, https://www.simonemanganelli.org/Simone/Research_files/QVAR_May_2021_07.pdf

[5] White *et al.* (2015) have been the first to put forward the idea of a quantile VAR.