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Research article

Comparative investment analysis between crypto and conventional financial assets amid heightened geopolitical risk

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ABSTRACT

This empirical research study aims to investigate the asymmetric spillovers among crypto and key financial assets such as gold, equity, bonds, and the dollar-to-ruble exchange rate volatility, focusing on new developments during the Russia-Ukraine conflict in 2022. Utilizing time- and frequency-domain methodologies, this study conducts an in-depth analysis employing daily frequency data from January 01, 2018, to May 30, 2023. The study employs value at risk and conditional value at risk estimations to assess potential losses in the portfolio during the crisis. The findings reveal that Bitcoin exhibits hedging ability, enabling investors to diversify risk among the underlying financial assets. The study observes a significant increase in Bitcoin investments during the crisis, leading to heightened volatility and uncertainty. Negative news has a stronger impact compared to positive news, underscoring the importance of prudent asset allocation for risk mitigation. The implications of our findings are particularly significant for financial policymakers and trade partners of Russia. The study urges them to differentiate their short- and long-term strategies and procurement contracts. In the long run, policymakers should be cognizant of the influence of the riskiness of crypto assets during economic crises, guiding the formulation of prudent policies and investment decision-making initiatives.

1. Introduction

Bitcoin, the original decentralized digital currency globally, has gained substantial traction and expansion, attributed to its potential as a value store, decentralized nature, and reliance on blockchain technology. Bitcoin's journey has been marked by significant volatility and a consistent upward price trajectory [1]. Investors have turned their attention to Bitcoin as an alternative investment alongside traditional financial assets, particularly during the COVID-19 pandemic, where its price reached an all-time high. However, a subsequent correction occurred during the bearish market phase, indicative of Bitcoin's characteristic price cycles with noticeable rallies and corrections, stemming from its highly volatile and unconventional fluctuations. In contemporary discourse, Bitcoin is acknowledged not only as a digital currency but also as an alternative investment and a hedge against conventional financial assets [2]. This study aims to scrutinize Bitcoin's correlation with gold, equity, bonds, and exchange rates post-COVID-19 and during the Russia-Ukraine conflict in 2022. The focus lies on evaluating Bitcoin's hedging and risk diversification capabilities in the Russian

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financial market during crises.

Various factors, including market sentiment, regulatory changes, technological advancements, and geopolitical shifts, influence Bitcoin's performance. The correlation between Bitcoin and gold, equity, bonds, and exchange rates exhibit temporal variability. Sohag and Ullah [3] affirm a positive correlation between investor sentiment and Bitcoin, whereas Bouri et al. [4] demonstrates a negative correlation, suggesting independent price movements from gold, stocks, and other commodities. De Pace and Rao [5] report a weak correlation, while Baur et al. [6], Fang et al. [7], and Hassan et al. [8] indicate low connectedness between Bitcoin and bonds. Bonds, being stable income generators, stand in contrast to the volatile and speculative nature of Bitcoin. The connection between Bitcoin and exchange rates is significant, particularly in the context of the Russian conflict with Ukraine, where examining this correlation gains particular importance. Positive correlations during crises have been observed (Li et al., 2022), although such correlations are contingent on regional factors [9], market dynamics [10], and investor behavior Bouri et al. [11,12]. It is crucial to note that Bitcoin-exchange rate correlations are dynamic and potentially influenced by various factors such as market conditions, regulatory changes, macroeconomic events, and media attention [13,14].

In economic crises, Bitcoin emerges as a financially independent tool [15], especially in the Russian economy facing stringent economic sanctions. Bitcoin provides capital protection [16], a reliable means for cross-border transactions [3], and an un-censorable payment system [17,18]. With the continuous evolution of modern financial markets and the robust position of cryptocurrencies in asset management, portfolio diversification is gaining prominence. Investors are increasingly incorporating Bitcoin into their portfolios due to growing interconnectivity among assets and markets (G.-J. [19]). Despite rapid financial market developments, the potential for external shocks impacting portfolio allocation during an economic crisis remains unexplored.

The current research study serves multiple objectives, focusing on the Russian financial market for specific reasons. Firstly, Russia's role as a major exporter of diverse assets attracts global investors. Secondly, facing economic sanctions from Western allies and the United States, the Russian economy contends with continuous struggles in the exchange rate between the ruble and the US dollar. Lastly, the unique combination of the COVID-19 epidemic and the Russia-Ukraine conflict sets the Russian financial market apart, warranting comprehensive examination.

The study's key finding suggests that Bitcoin can function as a hedging tool in the Russian financial market, demonstrating correlations with MOEX equity, Russian government 10-year bonds, and the USD/RUB exchange rate. Additionally, Bitcoin exhibits safe-haven properties, enabling risk diversification among other financial assets. Calculating the value at risk (VaR) and conditional value at risk (CVaR) using the Cornish-Fisher expansion for Bitcoin and underlying assets estimates potential losses in the selected portfolio. Notably, during the 2022 conflict with Ukraine, increased investments in Bitcoin were observed in the Russian financial market, leading to heightened volatility and uncertainty. These assets displayed a stronger response to negative news compared to positive news. Therefore, a cautious approach and prudent asset allocation are essential to mitigate risks. The study carries significant policy implications within the context of the ongoing Russia-Ukraine crisis in 2022.

The subsequent sections of this work include a comprehensive literature review, an introduction to the models utilized, an outline of the data sources, and an explanation of the methodology employed. The conclusion provides suggestions for international and Russian investors to navigate diverse market situations.

2. Literature review

Bitcoin has demonstrated its potential value for investors, particularly in times of crises and within economies subjected to sanctions. Ghorbel, Loukil et al. [20] explored its role as a hedge against inflationary pressures, while Diniz-Maganini et al. [21] emphasized its decentralized and borderless nature, facilitating cross-border transactions without reliance on traditional banking channels. In economies facing sanctions, Bitcoin serves as a financial asset for peer-to-peer transactions across borders, circumventing third-party intermediaries [22]. It offers a quicker and more accessible option for remittances (Q. [23]) and provides a degree of financial privacy in surveilled or restricted economies [3]. Additionally, Bitcoin presents investment opportunities for diversification beyond traditional assets in sanctioned economies like Russia [3]. Nonetheless, its utilization in the Russian financial market encounters hurdles, including regulatory developments, technological constraints, cybersecurity risks, and price volatility. This study offers suggestions for investors to consider these factors within the context of crises and sanctioned environments in Russia. Since its inception, Bitcoin has gained popularity due to its distinctive features, such as peer-to-peer decentralization and secure transactions [24]. Its independence from government intervention and taxation has positioned it as a preferred choice for transactions where traditional financial systems may be inaccessible. Investors increasingly adopt Bitcoin as an alternative to cash transfers, particularly during periods of sanctions and crises. Academic scholars have extensively delved into the correlation between Bitcoin and other financial assets, with a specific focus on dynamic correlations.

Research on the dynamic correlation between Bitcoin and traditional assets indicates that Bitcoin is relatively independent and exhibits a weak relationship with other financial assets [25]. Tsounis & Vlachvei (2018) found a weak and time-varying relationship between virtual currency and traditional assets using Copula estimation methods. The connection between Bitcoin and other assets is susceptible to external events, such as the Russia-Ukraine crisis, where Bitcoin functions as a decentralized tool rather than a hedging tool. Jin et al. [22] explored the causal relationship between Bitcoin and other financial assets using data-driven directed acyclic graph methods, revealing Bitcoin's overall independence but a lagging relationship with other assets in bear markets. Ghorbel, Frikha et al. (2022b) and Boubaker et al. [18] conducted Granger causality and cointegration tests, finding no stable long-term relationship between Bitcoin and gold, crude oil, stocks, savings, and exchange rates in the US market. Shaik et al. [26] studied the dynamic volatility connectedness among innovative technology communication, FinTech, and crypto assets, discovering that crypto and FinTech assets are more volatile compared to innovative technology communication assets. In the short term, stocks and exchange rates positively

affect Bitcoin, while interest rates have a negative impact. Corbet et al. [27] and Karim et al. [28] analyzed frequency domain and concluded that Bitcoin exhibits a significant level of independence from investable assets in the US financial market, providing diversification benefits for short-term investment. Tsounis & Vlachvei (2018), [29] and Wu et al. [30] identified a spillover effect between Bitcoin and the US market.

Scholars have conducted research on the impact of the COVID-19 epidemic (Zhang & He, 2021), and Sheikh et al. [31] studied the impact of conventional and shariah indices on changes in oil and gold prices for the USA, Europe, and Asian financial markets. The crisis of COVID-19 increased the volatility of all underlying markets simultaneously, with a more significant impact during the bear phase. Corbet et al. [27] focused on the Dow Jones Industrial Index, WTI Crude Oil, MOEX stock index, Shenzhen Component Index, and gold to study the influence of Bitcoin on COVID-19 using GARCH and DCC-GARCH models. Chemkha et al. [32] and Kayani et al. (2023) studied the Chicago oil volatility transmission on European stock markets, finding a statistically significant inverse link that changes over time across various sample markets. Particularly, the Chicago oil volatility index was identified as an influential source of primary energy risk on the European stock market. Bardou et al. [33] and Jin et al. [34] used the GARCH model to study the risk relationship between Bitcoin and the S&P 500 during the COVID-19 epidemic. Goodell et al. [24] and [35] tested the effectiveness of Bitcoin in the context of the COVID-19 epidemic using the GARCH model, discovering that Bitcoin acts as a weak hedging tool and a potential weak safe-haven asset during market crises, significantly impacting the MSCI China index and industry index.

In existing literature, various methods have been employed to describe the correlation relationship of fluctuations in financial markets. The GARCH family model is commonly used to capture asset volatility. The correlation between Bitcoin and exchange rates is crucial for portfolio diversification, especially concerning historical fluctuations between rubles and the US dollar. The GARCH model proposed by Bollerslev [36] and extended by [37] assumes that stock and exchange rate return series follow a normal distribution and incorporates an unobservable error term in the conditional variance equation. Khan et al. [38] investigated returns spillovers across equity markets in Asian emerging economies, using two spillover estimation methodologies, BK 2018 and DY 2012, to measure short-term and long-term spillover transmission.

However, the standard GARCH model falls short in accounting for asymmetrical fluctuations, necessitating the use of asymmetric GARCH models. The EGARCH model, introduced by Nelson [39], addresses dynamic asymmetry by adding exogenous variables to the mean equation. Similarly, the GJR-GARCH model, proposed by Glosten et al. [40], incorporates asymmetrical assumptions and performs well in capturing market shocks. Bouri et al. [41] utilized the DCC-GARCH model to study the dynamic correlation between Bitcoin and other assets, observing a weakening correlation between Australian litigation funds and Bitcoin since the outbreak of COVID-19. Ghorbel, Frikha et al. (2022b) employed the MS-GARCH model, finding that Bitcoin cannot be considered a substitute for WTI crude oil and US natural gas spot during the COVID-19 epidemic. Goodell et al. [24] and [42] used the TV-MS-GARCH model with multiple distributions to examine the relationship between Bitcoin price, transaction volume, and Google search volume.

This research study aligns with Harry Markowitz's modern portfolio theory proposed in 1952, emphasizing the rationality of investors and the utilization of market information for creating investment portfolios. The theory guides weight allocation to different assets based on their associated risks and introduces concepts of hedging and diversification to manage asset risk. Econometric estimations are employed in this study to provide strategic guidance on hedging and diversification among Bitcoin, gold, equity bonds, and exchange rates in the Russian financial market. The aim is to offer suggestions to investors and fund managers regarding investment allocation among various options. By constructing a portfolio of assets exhibiting non-perfect correlation, the study addresses the current risk level in the Russian financial market. Weight allocation to securities is determined using the mean-variance model, aiming to maximize expected returns while minimizing the variance of the total investment. Fig. 1 illustrates the theoretical and conceptual framework of the article.

3. Methodology

This research study aims to analyze the relationship between Bitcoin and the main assets in the Russian financial market, specifically focusing on the MOEX stock index, gold spot-trading, MOEX 10-year bonds index, and the exchange rate of the US dollar into rubles. The study considers these variables as exogenous and examines their correlation with other underlying assets during the crises of the COVID-19 epidemic and the Russia-Ukraine conflict in 2022.

3.1. Data description

The study utilized daily closing price data from the well-known cryptocurrency website, *CoinMarketCap* https://coinmarketcap.com for Bitcoin. The data for other financial assets were derived from the Moscow stock exchange (MOEX), starting from January 01, 2018, to May 30, 2023, resulting in a total of 1340 observations. The motivation for selection of the data time-period is to examine the possible impact of COIVD-19 and Russian Ukraine conflict (2022). The study specifically used the MOEX Russia Index[1] for the stock market, gold spot-trading (RUB per gram), the MOEX 10-years government bond index, and the USD to Rubles exchange rate. The analysis considered the global pandemic outbreak starting from December 31, 2019, and two windows were selected to conduct a comprehensive examination and capture the interactions among the indices. As the prices of the selected indices differ significantly

[1] The MOEX Russia Index is a major stock market index that tracks the performance of the 50 largest and most liquid Russian companies from 10 main economy sectors listed with Moscow Stock Exchange. It is a capitalization-weighted composite index where the MOEX has a base value of 100. The gold prices are derived from FX and Precious Metals Market.

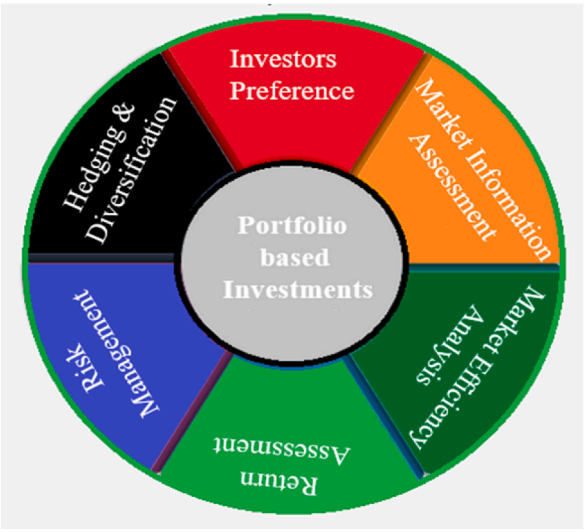


Fig. 1. Theoretical and Conceptual Framework of the study.
Source: Authors Calculation

from those of other financial assets, logarithmic rates of return were employed to calculate the price data, preventing parameter values from becoming excessively large.

$$Rt = \ln (Pt / Pt - 1) \times 100 \quad (1)$$

Eq.— (1) represents the econometric derivation of the return series generated for each financial assets using historical data where the Pt represents the asset price, and Rt is the logarithmic rate of return. Fig. 2 shows the prices and yields of the MOEX Russia Index, MOEX Gold, and the exchange rate of USD/RUB respectively. For the convenience of expression, various assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the tables and figures.

3.2. Model specification

To measure volatility persistence, the study applies the GJR-GARCH estimation model proposed by Bollerslev [36]. Furthermore, the study utilizes VaR and CVaR, proposed by Nelson [39], to assess the risk associated with the selected assets and asset pairs for portfolio diversification. Previous studies have employed GARCH models to analyze financial time series but considering the potential structural changes following consecutive crises in the Russian financial market, this study employs the GJR-GARCH model to examine short and long timescales. These models can account for unknown parameters that occasionally emerge in the market at unspecified times. Given the high volatility and susceptibility of the Bitcoin market to small market changes and its potential impact on positive and negative information shocks to investigate the effects of each market before and after the health and peace crises.

3.3. GJR-GARCH (1,1)-t model

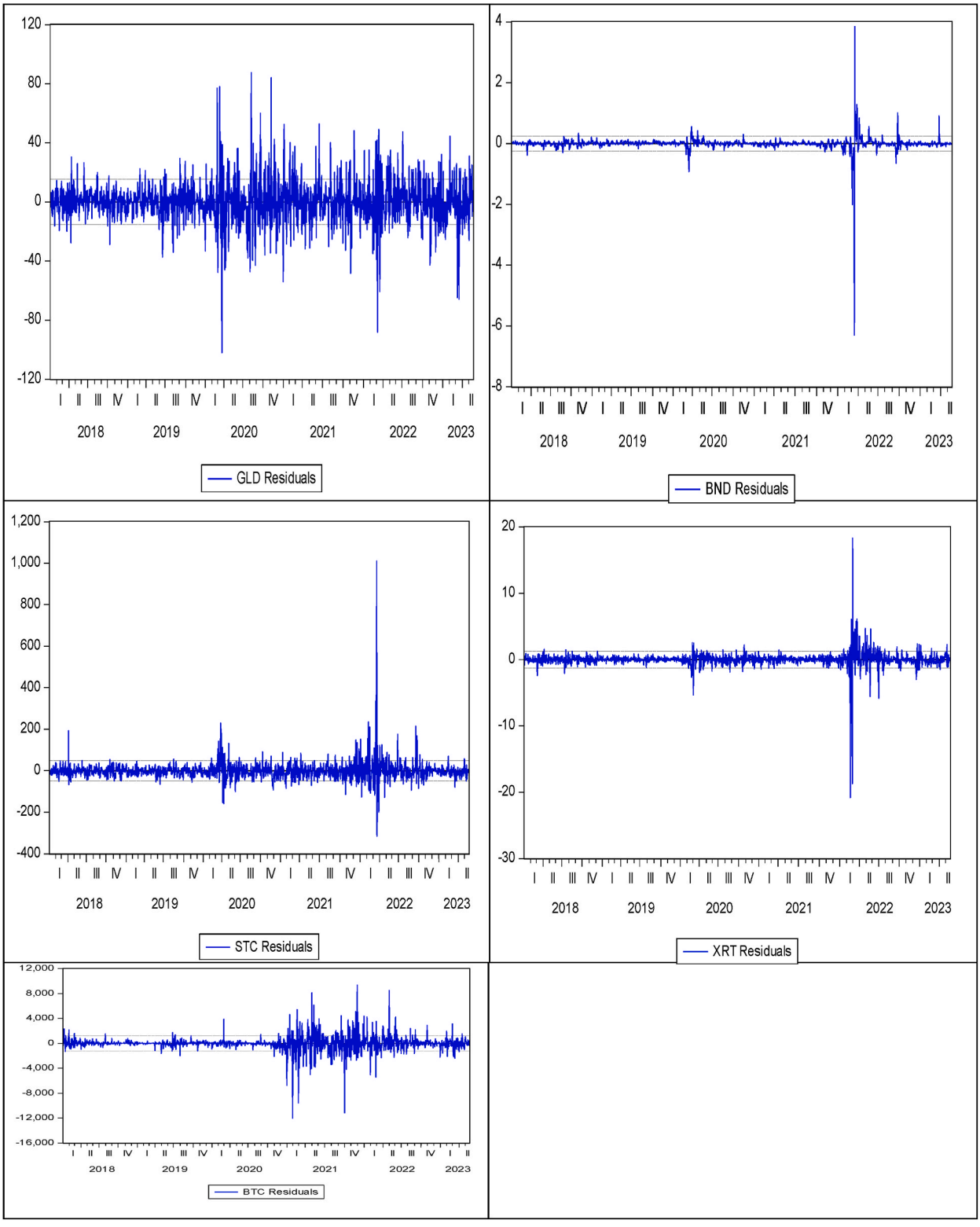
This model es estimated to examine the possible asymmetric conditional variance within the preview of all assets utilized in the study:

$$Ht = \omega + \alpha 1 \varepsilon\, 2\, t - 1 + \gamma 1\, It - 1 \varepsilon\, 2\, t - 1 + \beta 1\, ht - 1 \quad (2)$$

Eq.— (2) represents the presentation of econometric derivation of the estimation GJR-GARCH model among them, $\omega > 0, \alpha 1 \geq 0, \beta 1 \geq 0, \alpha 1 + \gamma 1 \geq 0, \alpha 1 + \beta 1 < 1$ It is the threshold item, $\varepsilon t < 0$ means bad news $\varepsilon t \geq 0$ means good news it $= 0$ Specific to the impact on the conditional variance, when the market is favorable, the coefficient of the volatility item is $\alpha 1$, and when there is a negative market, the coefficient of the volatility item is $\alpha 1 + \gamma 1$. The response of the variance to the information shock is asymmetric, if and only if the coefficient of the threshold term $\gamma 1 \neq 0$..

Since the model adds an asymmetric factor to the conditional variance, it can extract the information impact curve from it, and the relationship between the residual and the conditional variance. The correlation relationship is described. The horizontal axis of the information impact curve is the residual, and the positive and negative values can be regarded as positive and negative information; the vertical axis is the conditional variance, which measures.

Therefore, the information shock curve can reflect the correlation between positive and negative information and volatility. Due to the existence of asymmetric factors, it makes the image asymmetric, so that the leverage effect of the research object can be analyzed.



(caption on next page)

Fig. 2. Bitcoin, Gold, Bonds, Equity, and Exchange Rate spot index response to the economic crisis during COVID-19 and Russia Ukraine conflict 2023. Source author's calculation
Note: The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the figures.**Crisis Impact and response of each Assets; Panel A** (top-left): Gold price volatility; **Panel B** (top-left): Govt Bond volatility; **Panel C** (Middle-left): Equity volatility; **Panel D** (middle-right): Exchange rate volatility; **Panel E** (Bottom-left): Crypto asset volatility. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

3.4. VaR and CVaR

Following the Russian financial market which is facing the price and volatility risks associated with the uncertain market conditions. VaR and CVaR [33] are certainly the best known and the most reliable risk measurement estimation tools used for market in similar conditions such as Russian financial market, especially for the evaluation of extreme losses potentially faced to the investors in Russian financial market. In line with other crisis the risk measures in numerical term are challenge after the crises of COVID-19 and current conflict between Russia and Ukraine (2022). In addition, as discussed, the literature that the return sequence of financial assets does not distribute with standard normal conditions as in our Bitcoin case, whose price has high volatility. Therefore, we use the Cornish Fisher (Maillard, 2012) estimation method for calculation. This study uses the VaR and CVaR measurement estimation to measure the downside risk β of the Bitcoin market under a certain confidence level α during both crises are represented as follows:

$$\mathrm{VaR}(\alpha) = - \ \mathrm{F} \ - 1 \, \mathrm{r} \, (1 \ - \ \alpha) \tag{3}$$

Eq.— (3) represents the presentation of econometric derivation of the estimation VaR model, among them, Fr represents the cumulative distribution function of the portfolio return rate r. Since VaR does not have sub-additivity, and only measures the maximum loss under the confidence level, the additional loss beyond the maximum loss cannot be estimated. Therefore, CVaR, which has sub-additivity and can measure excess losses, is often used as a risk measure for asset portfolios. It is defined as follows:

$$\mathrm{VaR}(\alpha) = - \ \mathrm{E}(\mathrm{r} \mid \mathrm{r} \leq - \ \mathrm{VaR}) = - \int - \mathrm{VaR} \ - \infty \mathrm{zf} \ \mathrm{r}(\mathrm{z}) \mathrm{dz} \ \mathrm{Fr}(-\mathrm{VaR}) = - \int - \mathrm{VaR} \ - \infty \mathrm{zf} \ \mathrm{r}(\mathrm{z}) \mathrm{dz} \ 1 - \alpha \tag{4}$$

Eq.— (4) represents the presentation of econometric derivation of extension of the estimation for probabilistic portfolio returns. Where the Fr(z) is the probability density function of portfolio returns.

3.5. Cornish Fisher calculation method of VaR and CVaR

To deal with non-normality distribution of asset price or return the Cornish Fisher (Maillard, 2012) expansion is a relatively easy and parsimonious. This estimation allows us to implement portfolio optimization with a risk measure more sophisticated than variance. Therefore, we applied the Cornish Fisher along with Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR). The study normalized portfolio returns as $\mathrm{r} - \mu \mathrm{p} \ \sigma \mathrm{p}$ Cornish-Fisher expansion of the quantile α, and the fourth moment is retained:

$$\mathrm{q} = \mathrm{z}(\alpha) + 1 \, 6 \, [\mathrm{z} \, 2 \, (\alpha) \ - \ 1] \mathrm{Sp} + 124 \, [\mathrm{z} \, 3 \, (\alpha) \ - \ 3\mathrm{z}(\alpha)] \mathrm{Kp} \ - 136 \, [2\mathrm{z} \, 3 \, (\alpha) \ - \ 5\mathrm{z}(\alpha)] \mathrm{S} \, 2 \, \mathrm{p} \tag{5}$$

Eq.— (5) represents the presentation of econometric derivation of the estimation Cornish-Fisher expansion of the quantile model Among them, $\mu \mathrm{p}, \sigma \mathrm{p}, \mathrm{Sp}, \mathrm{Kp}$ are the mean, standard deviation, skewness and kurtosis respectively; Z(α), is α, quantile of standard normal distribution. Based on Cornish Fisher's VaR and CVaR calculation formulas are as follows:

$$\mathrm{VaR}(1 \ - \ \alpha) = \mu \mathrm{p} + \sigma \mathrm{p} \, \mathrm{q} \tag{6}$$

$$\mathrm{CVaR}(1 \ - \ \alpha) = \sigma \mathrm{p}(\mathrm{M1} + 16 \, (\mathrm{M2} \ - \ 1) \, \mathrm{Sp} - 124 \, (\mathrm{M3} \ - \ 3\mathrm{M1} \,) \mathrm{Kp} + 136 \, (2\mathrm{M3} \ - \ 5\mathrm{M1} \,) \mathrm{S} \, 2 \, \mathrm{p}) \tag{7}$$

Eq.— (6) and (7) represent the econometric derivation of the Cornish Fisher along with Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR) respectively where both models the, $\mathrm{M1} = 1$ alpha $\int \mathrm{z}(\alpha) - \infty \mathrm{xf}(\mathrm{x}) \mathrm{dx}$, and the $\mathrm{M1} = 1$ alpha $\int \mathrm{z}(\alpha) - \infty \mathrm{x3f}(\mathrm{x}) \mathrm{dx}$ while the f(x) is the probabilistic standard normal distribution function used in the model.

4. Results, empirical findings and discussion

The study utilizes extended GARCH econometric estimation models to analyze the correlation between Bitcoin and various other financial assets in the Russian financial market, including the MOEX stock index, gold spot-trading, the MOEX 10-year government bond index, and the exchange rate of US dollar to rubles are examined. The focus is on studying the correlation during the COVID-19 epidemic and the Russian Ukraine conflict in 2022, as these crises are expected to impact the correlation among the underlying assets. Additionally, the analysis extends to include estimation models of GJR-GARCH to assess the risk of Bitcoin in relation to other financial assets. The analysis methods also include value at risk (VaR) and conditional value at risk (CVaR) calculated based on the Cornish-Fisher (CF) expansion. The reason for employing this estimation is to study the external information shocks occurring in response to the ongoing crises.

4.1. Correlation analysis between bitcoin and major assets in Russian financial market

According to the descriptive statistics presented in Table 1, Bitcoin exhibits the highest average return rate and the largest standard deviation, indicating that it is a high-yield, high-risk asset. This finding is consistent with conclusions drawn in previous literature. In terms of kurtosis and skewness, Bitcoin, the MOEX Russia stock index, and the MOEX 10 years government bond index show negative skewness, indicating a left-skewed distribution. On the other hand, MOEX gold spot-trading and the exchange rate USD/RUB are exhibits positive skewness, indicating a right-skewed distribution. Bitcoin also demonstrates the highest kurtosis value, followed by MOEX gold, with both exceeding the level 3.00. The kurtosis of the USD/RUB exchange rate is also close to 3.00, indicating a peaked and heavy-tailed distribution, which aligns with the characteristics of gold. Since skewness of a normal distribution is generally close to 0 and kurtosis is close to 3.00, it can be preliminarily concluded that the data does not conform to the distributional characteristics of a time series. Table 2 exhibits the correlation between crypto and conventional assets. The overall correlation among underlined assets is observed stronger as explained by the theory. In particular, Bitcoin investment has a positive relation with gold and exchange rate, while the study observed BTC with negative relation to all other underlined assets. Similarly, the equity and bonds market is negatively associated to the exchange rate.

4.2. Risk and return parameters estimations

To precisely evaluate the adherence of the asset, return series to a normal distribution, a normality test is executed. The results from the Shapiro-Wilk test reveal exceedingly small p-values, specifically 0.01, leading to the rejection of the null hypothesis. Consequently, it can be inferred that the five asset return series deviate from a normal distribution.

To ascertain the feasibility of establishing an GJR-based GARCH family model, a stationarity test is conducted on the return sequence. The ADF unit root test is applied, with the null hypothesis assuming the presence of a unit root and non-stationarity. The test outcomes present a significant p-value, resulting in the rejection of the null hypothesis. Assuming normal distribution of the return series, an GJR-based GARCH family model proves suitable for estimation and analysis. This model scrutinizes changes in the relationship between Bitcoin and the primary assets of the Russian financial market before and after both crises, with the parameter estimation results for each asset detailed in Table 3.

Table 3 exhibits the parameter estimation outcomes for Bitcoin and gold spot-trading, MOEX stock index, MOEX bond index, and the USD to RUB exchange rate. Among these assets, the GJR-GARCH model demonstrates the lowest logarithmic likelihood function, making it the preferred choice for analysis. This aligns with the approach utilized by Yousaf et al. [43] in examining various assets. Generally, if the underlying assets display negative or uncorrelated relationships, they can function as mutual hedging tools. In our scenario, Bitcoin and gold in the Russian financial market emerge as assets suitable for mutual risk-avoidance. Conversely, a positive correlation among assets implies their potential as mutual diversification tools.

Based on the parameter estimation results, the estimated values of $\beta 0$ and $\beta 1$ are consistently positive across all models, indicating that Bitcoin holds a dominant position in the Russian financial market in the long run. This dominance is attributed to economic sanctions [3] and Russia's banking system suspension from SWIFT [32], creating challenges for investors in transferring financial deposits. Consequently, Bitcoin and gold have become primary choices for investors.

Moreover, the value of $\beta 2$ is negative and statistically insignificant, suggesting that Bitcoin acted as a weak hedging tool for the main gold contract during the crises of the COVID-19 epidemic and the Russian-Ukraine conflict in 2022. However, the value of $\beta 3$ is positive but statistically insignificant, indicating that Bitcoin served as a weak decentralized tool for the Russian gold contract during both crises. The parameter estimation results between Bitcoin and the MOEX Stock Index indicate that the estimated value of $\beta 1$ is positive but statistically insignificant, suggesting that Bitcoin serves as a weak decentralized tool for the MOEX stock index in the long run. Similarly, the estimated value of $\beta 2$ is positive but again insignificant, indicating that Bitcoin is not an effective diversification tool for the MOEX Stock Index. Furthermore, the estimated value of $\beta 3$ is significantly negative, indicating that Bitcoin acts as a strong hedging tool for the MOEX stock index during the COVID-19 epidemic and the Russian-Ukraine crises in 2022. Similarly, the parameter estimation results between Bitcoin and bonds indicate that the value of $\beta 1$ is negative and statistically insignificant, suggesting that Bitcoin is a weak hedging tool for the MOEX Bond Index in the long run. The estimated value of $\beta 2$ is positive but also insignificant, indicating that Bitcoin has a weak diversification effect on the MOEX Bond Index. On the other hand, the estimated value of $\beta 3$ is

Table-1
Summary statistics.

Summary	BTC	Gold	Stock	Bond	USD/RUB
Mean	0.313	0.036	−0.019	0.031	0.002
Median	0.087	0.022	0.037	0.051	0.001
Max.	33.679	4.278	5.358	5.412	1.479
Min.	−34.376	−3.712	−7.018	−7.720	−1.070
Std. Div.	6.274	0.686	2.241	1.285	0.394
Skewness	−0.607	0.091	−0.651	−0.365	0.301
Kurtosis	8.160	6.217	6.076	4.264	2.538
Obs.	1340	1340	1340	1340	1340

Note: The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the table.

Table- 2
Static correlation coefficients among assets.

	BTC	Gold	Stock	Bond	USD/RUB
BTC	1.000				
Gold	0.205	1.000			
Stock	−0.006	−0.085	1.000		
Bond	−0.010	−0.078	0.843	1.000	
USD/RUB	0.051	−0.032	−0.025	−0.029	1.000

Note: The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the table.

Table-3
Parameter estimation results of Bitcoin and other financial assets.

Parameter	Gold	Bonds	X-rate	Stock
μ	0.021	0.032	0.042	0.012
	(0.150)	(0.110)	(0.155)	(0.127)
Φ	−0.09	−0.010	−0.003	−0.006
	(-0.148)	(-0.202)	(-0.263)	(-0.348)
α	0.080***	0.086	0.073***	0.087***
	(2.753)	(2.063)	(2.720)	(4.065)
β0	0.651***	0.671***	0.642***	0.674***
	(14.173)	(14.553)	(12.050)	(14.433)
β1	0.688**	−0.011	1.015	0.067
	(2.100)	(-0.034)	(1.438)	(0.268)
β2	−0.390	0.408	−0.316	0.507
	(-0.360)	(871)	(-0.108)	(0.772)
β3	0.027	−0.726**	0.038	−0.750***
	(0.570)	(-1.223)	(0.015)	(0.018)
ω	3.240***	1.720***	3.541***	1.586***
	(2.815)	(2.780)	(2.088)	(1.708)
ϒ	0.876**	0.067*	0.105**	0.072
	(2.036)	(1.825)	(2.118)	(0.827)
Sharpe	3.026***	3.086***	2.076***	2.082***
	(11.655)	(10.780)	(11.471)	(10.838)
Log Likelihood	−2312.109	−2212.424	−2212.424	−2312.313

Note: The signs *, **, *** represent the level of significance at 10 %, 5 % and 1 %, respectively. The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the tables and figures.

significantly negative, indicating that Bitcoin serves as a strong hedging tool for the MOEX bond index during the crisis period.

The parameter estimation results between Bitcoin and the USD/RUB exchange rate indicate that the value of β1 is positive but statistically insignificant, suggesting that in the long run, Bitcoin is a weakly decentralized tool for the USD/RUB exchange rate. The estimated value of β2 is negative and also insignificant, indicating that Bitcoin is a weak hedging tool for the USD/RUB exchange rate prior to the epidemic. Moreover, the estimated value of β3 is positive but not significant, indicating that Bitcoin exhibits weak hedging capabilities against the USD/RUB exchange rate during the epidemic. It also serves as a weak diversification tool for the RUB exchange rate.

4.2.1. Estimation for hedge diversification and save heaven analysis

Employing a methodology akin to that of Khan et al [10], Baur et al. (2010), and Ratner et al. (2012) concerning hedging, diversification, and forecasting safe haven properties, as well as assessing the volatility of the underlying assets, we delve into the role of Bitcoin as a hedge and safe haven amid market volatility risks, particularly in the context of the Russian financial crisis. Table 4

Table 4
Dynamic correlations between BTC and other underlined assets during market volatility and the Russian Ukraine conflict 2022 crisis.

Indices	Hedge(β_0)	Quantile for Underlined Assets			Russian Crisis
		(β_1 10 %)	(β_2 5 %)	(β_2 1 %)	
BTC	−0.212	−0.125	−0.510	−0.221	−0.221
Gold	−0.287	−0.220	−0.227	−0.251	−0.251
Stock	−0.270	−0.278	−0.258	−0.412	−0.412
Bonds	−0.275	−0.712	−0.218	−0.220	−0.220
USD/RUB	−0.284	−0.255	−0.241	−0.245	−0.245

Note: ***, **, * indicate significance at the 10 %, 5 %, and 1 % levels, respectively. The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the tables and figures.

illustrates the dynamic correlations between BTC and other underlying assets during intervals of market volatility and the Russian-Ukraine conflict in 2022. The presence of negative coefficients in β0, β1, β2, and β3 signifies robust hedging properties. Coefficients more negative than the mean GJR-GARCH suggest a pronounced presence of safe haven properties. The analysis concludes that all assets, notably BTC, exhibit noteworthy hedging properties during periods of market volatility and the Russian-Ukraine conflict. This is evident through consistently negative coefficients across various measures. In these tumultuous periods, the assets not only functioned as effective hedges but also as substantial safe havens, as indicated by coefficients more negative than the mean GJR-GARCH values. This underscores their potential utility in portfolios as instruments for mitigating risk during intense market pressures.

The impact of major assets in the Russian financial market on each other is assessed using the hypotheses H0: $\beta 1 = \beta 3$ to test the equality of relationships, and H0: $\beta 2 = \beta 3$ to test the similarity of correlations before and after the crises. The results of the Wald tests are presented in Table 5. According to the significant results of the hypothesis tests in Tables 5 and it can be concluded that the correlation between Bitcoin and the main asset in the Russian financial market undergoes significant changes following the COVID-19 epidemic and, particularly, the ongoing conflict between Russia and Ukraine. Therefore, these crises have a notable impact on the relationship between Bitcoin and the Russian financial market. Furthermore, our study reveals that Bitcoin performs strongly as a diversification tool for the MOEX gold and MOEX stock indices. While Bitcoin works as a weak hedging tool for the MOEX Bond Index and a weak diversification alternative financial asset for the USD/RUB exchange rate.

4.3. Risk analysis between bitcoin and major assets in Russia financial market

This study employs the Cornish-Fisher estimation method to calculate the value at risk (VaR) and conditional value at risk (CVaR), assessing the risk exposure of the Bitcoin market. A comparative analysis is conducted with the historical simulation method and the variance-covariance method, visually represented in Figs. 3 and 4 exhibits the projection estimation for VaR and CVaR, respectively. The figures depict the time-varying results for VaR and CVaR for Bitcoin derived from the three methods, with a vertical dotted line marking the impact of both crises - COVID-19 and the Ukraine issue. It is evident that during market crises, both VaR and CVaR witness a significant increase, underscoring the robust performance of the Bitcoin market in the Russian financial landscape during these challenging periods.

Moreover, the Cornish-Fisher method yields the highest calculation result, whereas the other two methods underestimate market risk. Before the onset of the COVID-19 outbreak, the calculation results from the three methods were relatively similar. Therefore, the Cornish-Fisher method is considered appropriate for evaluating the Bitcoin market's performance, especially during crisis situations. Based on the risk measurement results of VaR and CVaR, investors are advised to exercise caution during market crises and contemplate reducing their Bitcoin holdings in response to sharp price declines.

The figures illustrate the impact of information shocks among the underlying securities such as equity gold, bonds, and the USD/RUB exchange rate in the Russian financial market. Both figures overall show asymmetrical shocks, suggesting a leverage effect among the main assets in the market. Specifically, the investment in MOEX gold spot trading contracts on Bitcoin is less impactful than the same magnitude increase compared to other assets. This implies that the Bitcoin market is more responsive to positive news regarding the MOEX gold main contract and experiences relatively higher volatility. Conversely, the response to negative news, such as changes in interest rates, has a more pronounced impact on Bitcoin compared to positive news. This indicates a negative relationship between Bitcoin and the MOEX stock index, MOEX 10 years government Bond Index, and USD/RUB exchange rate. These findings contradict those of [43] and [44] for the global market. However, the correlation of Bitcoin with gold, stocks, bonds, and exchange rates in the Russian financial market exhibits unique dynamics compared to other global financial markets. Investors need to exercise caution in portfolio diversification and hedging strategies for the underlying assets.

4.4. Discussion

In times of economic crises, the Russian economy grapples with various challenges such as economic sanctions, currency depreciation, and inflation. In response, policymakers actively seek alternative strategies to mitigate risks associated with the financial market. This study delves into the potential role of Bitcoin in supporting investors and businesses within the Russian context. While Bitcoin is often considered a hedge against traditional assets, offering portfolio diversification and potential safe-haven properties, our findings suggest that investing in Bitcoin during the ongoing crisis in the Russian economy carries risks due to its pronounced price volatility and lower market liquidity. The effectiveness of Bitcoin as a safe haven may exhibit variations across different markets, as evidenced by prior studies presenting mixed results. Additionally, the dynamics of the Russian economy may distinguish it from others. Bitcoin's limited supply and halving events contribute to its perceived value and price dynamics. Our research reveals that while

Table 5
Hypothesis testing of the relationship between Bitcoin and other assets before and after the crisis.

Hypothetical Test	BTC-Gold	BTC-Stock	BTC-Bond	BTC-USD/RUB
H0: $B_1 = B_3$	2.506*	2.116**	2.068	0.004
H0: $B_2 = B_3$	0.051**	0.141***	0.205*	0.301

Note: The signs *, **, *** represent the level of significance at 10 %, 5 % and 1 %, respectively. The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the tables and figures.

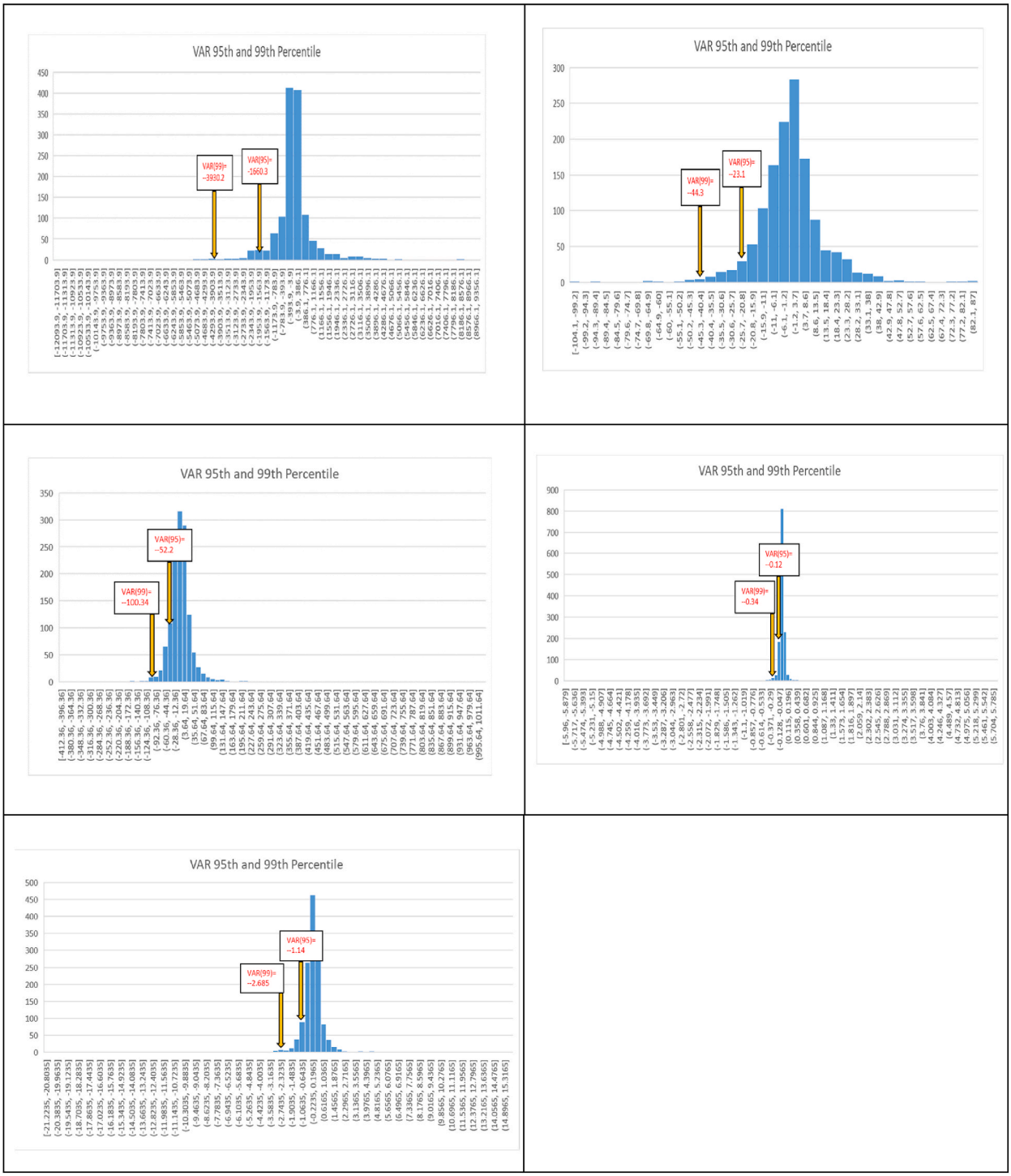


Fig. 3. Bitcoin, Gold, Bonds, Equity, and Exchange Rate Value at Risk (VAR) Estimation at 95 % and 99 % confidence level
The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the figures.**Value at Risk (VAR) Estimation at 95 % and 99 % confidence level; Panel A** (top-left): Gold spot price; Panel B (top-left): Govt Bond; Panel C (Middle-left): Equity Index; Panel D (middle-right): Exchange rate USD/RUB; Panel E (Bottom-left): Crypto asset. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

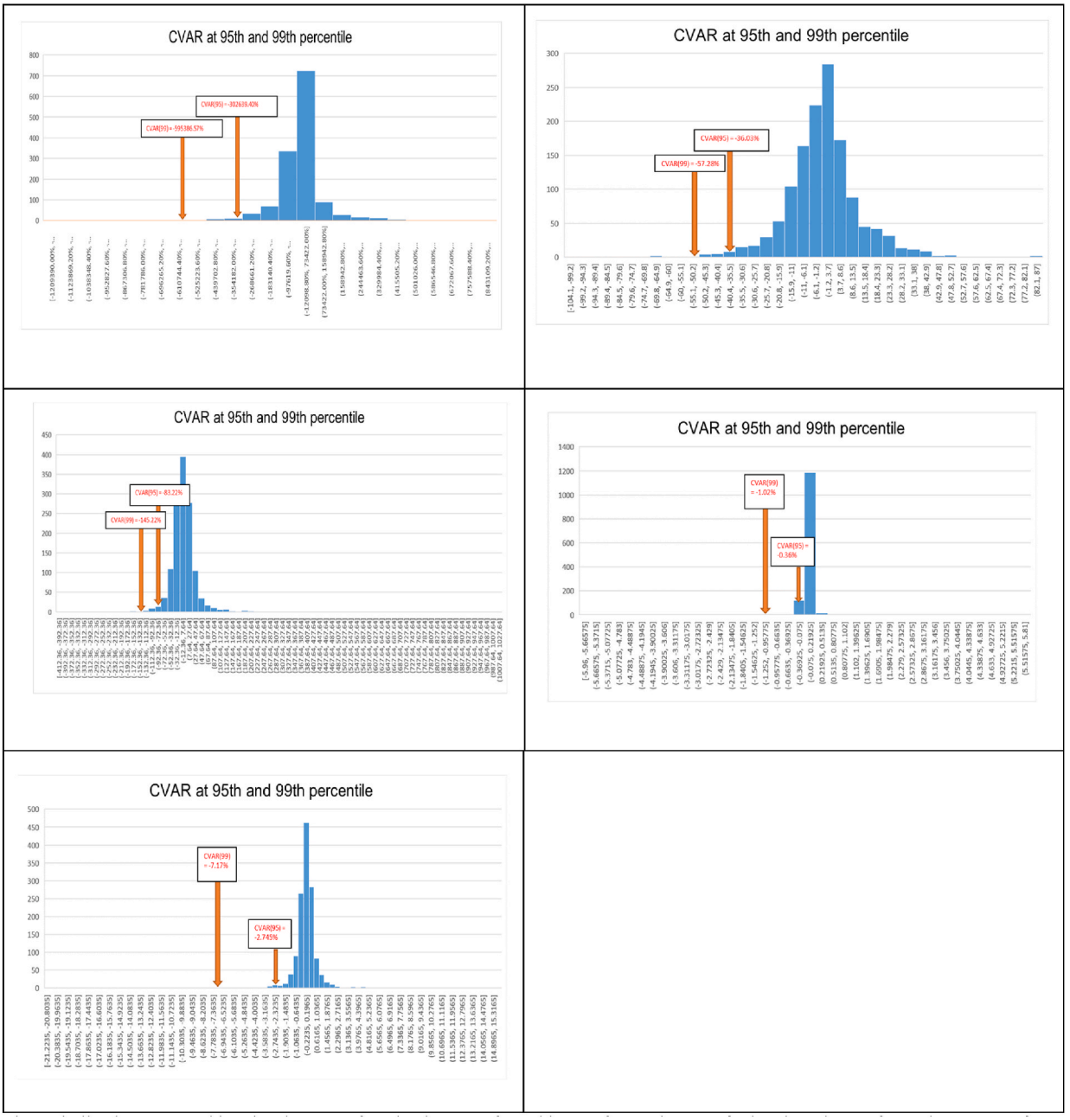


Fig. 4. Bitcoin, Gold, Bonds, Equity, and Exchange Rate Cumulative Value at Risk (CVAR) at 95 % and 99 % confidence level
The underlined assets are abbreviated as BTC for Bitcoin, GLD for gold, STC for stock, BND for bonds and XRT for exchange rate of USD/RUB are used in the figures.**Value at Risk (VAR) Estimation at 95 % and 99 % confidence level; Panel A** (top-left): Gold spot price; Panel B (top-left): Govt Bond; Panel C (Middle-left): Equity Index; Panel D (middle-right): Exchange rate USD/RUB; Panel E (Bottom-left): Crypto asset. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Bitcoin demonstrates hedging capabilities against equity, bonds, and exchange rates, investment in gold is generally perceived as safer than investment in Bitcoin.

The high price volatility of Bitcoin does present opportunities for speculative traders in the short run, as indicated by previous studies. The relationship between Bitcoin and stock markets has yielded mixed findings, with some research suggesting a positive correlation, indicating Bitcoin may act as a risk-on asset aligned with stock market movements, while other studies propose a weak or even negative correlation, suggesting Bitcoin's potential diversification benefits to stock portfolios. Numerous studies have explored the relationship between Bitcoin and gold, both considered alternative assets for storing value. In the context of the Russian financial market, both Bitcoin and gold can serve as risk-avoidance instruments. However, the correlation between Bitcoin and traditional

bonds, particularly Russian government 10-year bonds, remains relatively underexplored. Our findings indicate that Bitcoin exhibits strong hedging abilities against the MOEX Bond Index, especially during crisis periods. Yet, it is acknowledged that Bitcoin and bonds generally maintain a low correlation due to their distinct characteristics. Previous studies examining this relationship have produced mixed results, suggesting that Bitcoin's decentralized and speculative nature sets it apart from the fixed income and interest-bearing features of bonds.

5. Conclusion

This study employs GARCH estimation models to explore the interplay between Bitcoin and key assets in the Russian financial market before and after the COVID-19 epidemic and the Russian-Ukraine conflict in 2022. Specifically, our empirical analysis centers on alterations in correlations and risks, utilizing gold spot trading contracts, the MOEX stock index, MOEX 10-years government bond index, and the exchange rate (USD/RUB) as primary indicators of the Russian financial market. GJR-GARCH models with logarithmic returns are applied to the underlying securities. The motivation behind examining the Russian financial market during this specific timeline is driven by several objectives. The timeline for data analysis, spanning from January 01, 2018, to May 30, 2023, holds significance in relation to the economic crises of COVID-19 and the Russian-Ukrainian Crisis (2022). During these crises, the Russian financial market faced numerous economic sanctions, drawing global investor attention. Additionally, Russia's role as a major exporter of energy, metals, and commodities impacts the global financial market, making it a focal point for major investment companies worldwide. The selected financial assets in this study are considered crucial trading assets in global markets.

The study's findings reveal a robust static correlation coefficient between Bitcoin and the main financial assets, aligning with expectations from the literature review. The correlation between Bitcoin and underlying assets is time-varying, changing with market dynamics. The study observes a significant impact of information shocks on the Russian financial market, with positive news exerting a greater effect compared to negative news on the underlying assets. Preliminary analysis indicates that Bitcoin serves as a strong hedging tool and a weakly decentralized tool for the MOEX gold spot trading contract, MOEX stock index, MOEX 10-years government bond index, and USD/RUB exchange rate, respectively. The impact of negative news on Bitcoin volatility stemming from MOEX gold is relatively small, while positive news has a more substantial effect. Conversely, negative news has a greater impact on Bitcoin volatility concerning the MOEX stock index, MOEX bond index, and USD/RUB exchange rate.

Furthermore, the calculated Value at Risk (VaR) and Conditional Value at Risk (CVaR) results using the Cornish-Fisher method indicate a significant increase in risk in the Bitcoin market during both crisis periods, surpassing the risks estimated by the historical simulation method and the variance-covariance method. The Cornish-Fisher method proves to be more suitable for estimating Bitcoin's risk during crises due to its ability to account for high volatility characteristics. In summary, the correlation between Bitcoin returns and major assets in the Russian financial market is significant, with strong correlation observed during crises. Investors can adjust their asset allocation based on the impact of positive and negative news on Bitcoin market volatility to mitigate risks associated with the pandemic and the Russian-Ukraine conflict. This study offers valuable insights into the correlation between Bitcoin, gold, stocks, bonds, and the exchange rate in the Russian financial market, providing substantial investment information for asset portfolio allocation and decision-making during the ongoing crisis period. Despite the valuable insights provided, this study acknowledges its limitations. The employed estimation tools and methodology are relatively simplistic, and for future research, scholars are encouraged to utilize stochastic processes and probability transitions estimation for a more in-depth analysis of dynamic correlation changes. Improving the methodology will enhance the accuracy of findings and provide more constructive suggestions for investors and regulators.

Data availability

Data will be made available on request.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

CRediT authorship contribution statement

Mirzat Ullah: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Kazi Sohag:** Writing – review & editing, Supervision, Software, Resources, Project administration, Investigation, Formal analysis. **Hossam Haddad:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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