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The Risk and Return of Traditional and Alternative Investments Under the Impact of COVID-19

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Abstract

Background: In making investment decisions, asset risk and return are two crucial criteria on which investors base their decision. **Objectives:** This paper provides risk and return analysis and compares different traditional and alternative investments with special emphasis on the COVID-19 crisis. Assets included in the analysis are stocks, bonds, commodities, real estate, foreign exchange, cryptocurrencies, renewable energy sources, gold, and oil. **Methods/Approach:** The risk measures of standard deviation, Value at Risk (VaR), Conditional Value at Risk (CVaR), and Sharpe ratio are used to compare the representatives of each asset class. **Results:** The crisis had the highest impact on the risk of crude oil, renewable energy sources, real estate, and stocks, a slightly lower impact on the risk of commodities and gold, and a very low impact on the risk of bonds, foreign exchange, and cryptocurrencies. The order of assets regarding earning potential during the crisis, compared to the period before the crisis, changed significantly for commodities in a positive way and for gold and bonds in a negative way. **Conclusions:** This research shows that stocks won against all other assets, including gold and cryptocurrencies, during the COVID-19 crisis. The good features of a new alternative investment – renewable energy sources – with excellent earning potential are shown.

Introduction

Investors are always looking for higher earnings, more fruitful portfolio diversification, portfolio hedging, and, especially in crises, safe havens. In fulfilling these goals, various forms of alternative assets are considered. In addition, the long period of historically low interest rates led to an intensification of the search for more fruitful investments. In this sense, cryptocurrencies represent one of the most intriguing investment classes in recent times. Up to now, research shows that of the possible roles for cryptocurrencies, that of being an investment instrument is predominant, Baur et al. (2018), Bouri et al. (2017). Li et al. (2021), Ma et al. (2020), and Petukhina et al. (2021) demonstrate the benefits of cryptocurrency inclusion in portfolios.

Research regarding influences on cryptocurrency prices shows that attractiveness or popularity is the variable with the highest influence, Goczek and Skliarov (2019). This finding can be employed to explain the early spring 2021 sharp rise of primarily the Bitcoin price but also of other cryptocurrencies. Baur and Dimpfl (2018) found that in the case of cryptocurrencies, an asymmetric effect appears - positive shocks tend to increase volatility more than negative shocks, which is the opposite of what usually happens in stock markets. In explaining that appearance, they use the FOMO – Fear of Missing Out concept: uninformed investors without sufficient knowledge and financial literacy buy for fear of missing earnings at a time of rising cryptocurrency value. In addition, the existence of "pump and dump schemes" contributes to such an effect. Researching the impact of peoples' intention to hold Bitcoin based on their perception of its value and risk, Huang (2019) finds that most individuals do not understand either the values or the risks of Bitcoin.

As shown by the CRIX (Cryptocurrency Index) value and Bitcoin prices, market capitalization, and trading volumes from the CoinMarketCap, a more noticeable movement in their values started in 2017. Next, 2018 is the year of intensification of trading, and continuous value fluctuations and high volatility characterize all the time that follows. The monotonous period regarding price movements and trading until 2017 is excluded from further calculations. Therefore, the beginning date for further investigation is January 1, 2017. The closing date is November 11, 2021, the date of data collection. In that period, the COVID-19 pandemic happened - the first strong and deep crisis in the "life of cryptocurrencies". It allows for testing different features of cryptocurrencies in crisis and the possibility of retesting and redefining the role of traditional and alternative assets in a period of extreme uncertainty and volatility in world financial markets. Unfortunately, no one can say that challenging times are not ahead, and it is important to know how certain assets behave in a crisis, whether they recover, and how quickly. January 1, 2020, was taken as the starting date of the pandemic crisis in our research since the first case of Covid-19 in the US was recorded on January 21, 2020.

Regarding the consulted literature and data availability, besides cryptocurrencies, calculations and analyses are carried out for stocks, bonds, commodities, real estate, foreign exchange, gold, and oil, all assets that are rather common for research. Since there is recognition of renewable energy as the fastest-growing source of energy, as well as an industry with constant value growth (Lisin et al. 2021), it was decided to include also this alternative investment in the analysis.

However, in the world of investments, the focus should never be only on the rate of return. Along with this variable, the volatility of prices or risk is highly important. This paper aims to investigate the accompanying volatility of prices of observed assets and asset groups and to put it concerning returns, thus gaining earning potentials of observed investments, especially during the Covid-19 crisis. Together with the standard deviation and Sharpe ratio, the Value at Risk (VaR) and Conditional Value at Risk

(CVaR) are employed, which represent the common measures for the purpose, Pradhan et al. (2021), Takada et al. (2019).

Many questions intrigue us: How do certain types of assets behave in a crisis; should one remain faithful to traditional investments; is the popularity of an asset a good sign for investment; is it profitable to accept a higher risk of an asset in a crisis? Finally, a research hypothesis can be defined: The Covid-19 crisis has affected the prices and risk values, measured by different measures, of all observed assets and asset classes, but not in the same manner. Some assets and/or asset classes are more resistant and, despite the expected higher volatility, show quite satisfactory, if not better, earning potential in the crisis.

To investigate the research hypothesis, calculations were performed using the historical data of assets' closing prices taken in the observed, almost 5-year-long period, with the majority falling into the time of crisis. Using the rolling window of daily returns for 126 days, with a shift of 21 days, standard deviations, VaR, CVaR, and Sharpe ratio are calculated. VaR and CVaR are calculated for 90% and 95% significant levels. The total number of calculations is 52 per measure. In addition to insight into the movement of the absolute values of each of the measures, relative positions – ranks of all assets regarding risk measures and Sharpe ratio – are calculated and analyzed for the total observed period and the pre-crisis and crisis sub-periods.

The remaining paper is structured as follows. The Literature Review follows the Introduction. In the section Data and Methodology, the presentation of the sample of assets and asset groups (asset portfolios) is followed by descriptive statistics for asset returns and the correlation matrix. A short presentation of the risk measures closes this section. In the section Results and Discussion, the exposition of results and appropriate analysis and discussion are given. The study is closed with concluding remarks.

Literature Review

The Covid impact on cryptocurrencies, stocks and other assets has garnered the attention of researchers lately. The research of Aljinović et al. (2021) has confirmed the risky character of cryptocurrencies. During the COVID-19 crisis, along with the high and growing levels of risk, a higher earning potential has been recorded.

Bilka et al. (2021) investigate and conclude that cryptocurrencies improved portfolios' risk-return performance during the COVID-19 pandemic. Although, as expected, cryptocurrencies reported higher volatility values, their role as effective diversifiers remains in the pandemic crisis period. From the mean returns and standard deviations analysis, cryptocurrencies outperform traditional assets from January 1, 2020, to March 15, 2021.

Caferra et al. (2021) examine cryptocurrencies and stock markets during the COVID-19 pandemic using the wavelet coherence approach and the Markov switching autoregressive model. The authors show that financial contagion at the beginning of the COVID-19 crisis strongly affected cryptocurrency and stock markets since their prices fell steeply. While cryptocurrencies quickly recovered, stock markets did not. In addition, there is a finding about the correlation between these two markets over time, though at low frequencies. Aysan et al.'s (2021) study of cryptocurrency volatility confirmed their resilience concerning the pandemic.

Considering the data on the two cryptocurrencies, stock indices, and industry groups (30 industry portfolios), Maasoumi et al. (2021) examine possible similarities and connections before and after the COVID-19 pandemic outbreak. During the pre-COVID period, the highest similarity was found between NASDAQ and Bitcoin return distributions. A strong similarity was also found between Bitcoin and the coal, steel, and mining industries. With the beginning of the COVID-19 crisis, the distances

between all observed assets have decreased by 75% or more. The highest similarity was observed between Bitcoin and six different industry groups during the crisis period.

Yousaf et al. (2021) study explored the return and volatility spillovers between the cryptocurrency and US stock markets, using the VAR– BEKK–AGARCH model on hourly data in the pre-and COVID-19 periods. While insignificant spillovers were noticed in the pre-COVID period, in the COVID period, the return spillover from S&P 500 to the cryptocurrency market (represented by Litecoin, Bitcoin, and Ethereum) was recorded.

Farid et al.'s (2021) research focused on intraday volatility transmission between different assets and asset groups/markets in the pre-and COVID-19 period. The observed assets were gold, silver, oil, natural gas, and stocks. The research showed a significant pandemic impact on the volatility transmission between the observed assets, with the spillover peaks during the spread of the virus.

Yousaf (2021) examines the direction and significance of risk transmission from COVID-19 to markets of different metals and energy markets by introducing a "global fear index" and applying the multivariate BEKK-GARCH model. There is significant negative risk transmission for gold, palladium, and Brent oil markets, which suggests these markets' safe-haven properties. In contrast, transmission is positive in the WTI oil market case, and in the case of the industrial metal market, the transmission is insignificant.

All the studies have shown the big influence of the COVID-19 pandemic on different assets and asset classes, noticing differences in terms of periods, directions, and intensities.

Data and Methodology

In this paper, different types of assets are included in the analysis: stocks, bonds, commodities, real estate, foreign exchange, cryptocurrencies, renewable energy sources, gold, and oil. Table 1 shows the representatives of each asset class.

Table 1
Selected Assets

Asset Class	Representative
Stocks	S&P500
Bonds	Vanguard Total Bond Market Index ETF (BND)
Commodities	The Bloomberg Commodity Index (BCOM)
Real Estate	Dow Jones Real Estate Index (DJUSRE)
Foreign Exchange	The US Dollar Index (USDX)
Cryptocurrencies	Bitcoin (BTC)
Renewable Energy Sources	WilderHill Clean Energy Index (ECO)
Gold	Gold Continuous Contract futures (GC00)
Oil	West Texas Intermediate (WTI) crude oil

Source: The author's work.

The well-known and widely used S&P 500 index covers stocks of 500 leading US companies, representing about 80% of the market capitalization (S&P Global, 2022). The Vanguard Total Bond Market Index ETF (BND) is a market value-weighted index, which includes a wide spectrum of US dollar-denominated, investment grade, taxable, fixed-income securities with at least one-year maturities (ETF.com, 2022).

The Bloomberg Commodity Index (BCOM) represents a diversified and liquid benchmark for commodities investments. The index contains 23 exchange-traded contracts on physical commodities such as natural gas, oil, soybeans, corn, gold, silver,

aluminium, etc. (Bloomberg, 2020), in a way that no single commodity or commodity sector dominates the index (Bloomberg, 2016).

The Dow Jones Real Estate Index (DJUSRE) tracks the performance of real estate investment trusts (REIT), companies, and agencies involved in the real estate sector, either as owners, managers or developers (S&P Global, 2022b). The index covers parts of the US market with large, medium, and small capitalization (Holovatiuk, 2020).

The US Dollar Index (USDX) measures the US dollar value relative to the value of currencies of the US most significant trading partners. Currently, the index is calculated by factoring in the exchange rates of the Euro at 57.6%, the Japanese yen at 13.6%, the British pound (11.9%), the Canadian dollar (9.1%), Swedish krona (4.2%), and Swiss franc in 3.6% (Chen, 2022).

The WilderHill Clean Energy Index (ECO) covers the clean energy sector. Comprises companies involved in renewable energy supplies, energy storage and conversion, power delivery and conservation, greener utilities, and cleaner fuels (WilderShares, 2022). Together with Brent and Dubai Crude, West Texas Intermediate (WTI) crude oil is one of the three main benchmarks in oil pricing. It is considered one of the best oils in the world and is regularly included as the underlying commodity of the NYMEX (New York Mercantile Exchange) oil futures (Chen, 2020).

As a cryptocurrency representative, the most famous cryptocurrency – Bitcoin, is used. As emphasized in Aljinović et al. (2021), Bitcoin performs almost the same as the Cryptocurrency Index – CRIX, regarding all measures and variables, showing the prevailing professionals' opinion and use of Bitcoin as a benchmark of the world of cryptocurrencies is correct. Due to this feature of Bitcoin, research on Bitcoin's issues can be generalized to a large extent.

For each asset, daily close prices were collected from marketwatch.com on November 11, 2021. The observed period is from January 1, 2017, to November 11, 2021. Working days in which the price of one or more assets is unknown are excluded from the final dataset. The characteristics of the final dataset are summarized with descriptive statistics, which include the calculation of the minimum value (Min), first quartile (q1), median (Me), third quartile (q3), maximum value (Max), the expected value (μ), standard deviation (σ), variance (σ^2), skewness (α_3), and kurtosis (α_4) for each asset class. An overview of the descriptive statistics for returns of assets, along with the Jarque – Berra (JB) test for normality, is given in Table 2.

Table 2
Descriptive Statistics for Assets Returns

	S&P500	**USDX**	**BND**	**BCOM**	**DJUSRE**
Min	-9.99%	-1.70%	-5.59%	-5.58%	-10.97%
q1	-0.29%	-0.24%	-0.13%	-0.41%	-0.46%
Me	0.09%	0.00%	0.01%	0.07%	0.08%
q3	0.57%	0.21%	0.14%	0.48%	0.60%
Max	8.97%	1.68%	5.18%	3.37%	8.07%
μ	0.06%	-0.01%	0.00%	0.02%	0.03%
σ	1.13%	0.37%	0.34%	0.82%	1.30%
σ^2	0.0001	0.0000	0.0000	0.0001	0.0002
α_4	17.60	4.19	116.89	7.31	19.89
α_3	-0.69	0.10	-1.62	-0.78	-1.18
JB	10877.9***	73.71***	656589.58***	1063.21***	14706.93***

Note: *** indicate significance at the 0.01 level
Source: The author's calculations in MATLAB

Table 2
Descriptive Statistics for Assets Returns (continued)

	GC00	ECO	BTC	WTI
Min	-6.75%	-14.13%	-43.37%	-132.42%
q1	-0.37%	-0.85%	-1.80%	-1.03%
Me	0.06%	0.20%	0.34%	0.23%
q3	0.49%	1.18%	2.71%	1.27%
Max	5.78%	13.40%	28.71%	72.25%
μ	0.04%	0.13%	0.33%	0.04%
σ	0.92%	2.22%	5.15%	5.37%
σ^2	0.0001	0.0005	0.0027	0.0029
α_4	10.30	9.44	10.33	336.89
α_3	-0.40	-0.49	-0.67	-10.33
JB	2727.28***	2147.10***	2809.05***	5660722.63***

Note: *** indicate significance at the 0.01 level
Source: The author's calculations in MATLAB

Bitcoin has the largest expected return. The asset class with the second largest expected return, 2.5 times lower than the BTC expected return and greater than 0.1%, is renewable energy sources. Expected returns of all other assets are between 0% and 0.1%, while the USDX has a negative expected return. The standard deviation is the largest in the case of the oil asset class. This is followed by the standard deviation of BTC, which is only 0.22 percentage points lower, and the standard deviation of ECO, which is 2.4 times lower than the standard deviation of oil. From Table 2, at 1%, 5%, and 10% significance levels, it can be concluded that returns are not normally distributed for all assets. All assets are negatively skewed except the USDX, meaning the left tail is longer and fatter. WTI has the most negative skewness. At the same time, WTI has the largest kurtosis, equal to 336.89, which indicates leptokurtic distribution, meaning that the tails are heavier than those of a normal distribution, indicating a higher degree of risk and a higher probability of extreme values. The kurtosis of all other assets is significantly lower than WTI kurtosis but still greater than 3, also indicating leptokurtic distributions.

In addition, an analysis of the correlation between asset classes is made. Table 3 shows the correlation matrix computed based on Pearson's coefficient that measures the linear dependence of assets.

Table 3
Correlation Coefficients

	S&P500	USDX	BND	BCOM	DJUSRE	GC00	ECO	BTC	CrudeOil WTI
S&P500	1.0000	-0.0890	-0.0076	0.3643	0.7396	0.0954	0.6895	0.1807	0.1917
USDX	-0.0890	1.0000	-0.2077	-0.2377	-0.1442	-0.3858	-0.1108	-0.0543	-0.0244
BND	-0.0076	-0.2077	1.0000	-0.0376	0.0804	0.2019	0.0018	0.1035	-0.0162
BCOM	0.3643	-0.2377	-0.0376	1.0000	0.2816	0.3482	0.3660	0.0870	0.4553
DJUSRE	0.7396	-0.1442	0.0804	0.2816	1.0000	0.1742	0.5251	0.1274	0.0903
GC00	0.0954	-0.3858	0.2019	0.3482	0.1742	1.0000	0.1378	0.0838	0.0904
ECO	0.6895	-0.1108	0.0018	0.3660	0.5251	0.1378	1.0000	0.1619	0.1720
BTC	0.1807	-0.0543	0.1035	0.0870	0.1274	0.0838	0.1619	1.0000	0.0341
CrudeOil WTI	0.1917	-0.0244	-0.0162	0.4553	0.0903	0.0904	0.1720	0.0341	1.0000

Source: The author's calculations in MATLAB.

From the obtained correlation coefficients, it can be noticed that most asset classes are low correlated. Exceptions to this are stocks, real estate, and renewable energy

sources. A significant positive correlation is identified between stocks and real estate, where the correlation coefficient reaches 0.7396. Stocks and renewable energy sources are also highly positively correlated, with a correlation coefficient of 0.6895. Further positive correlation greater than 0.5 is found in the case of real estate and renewable energy sources. The asset class negatively correlated with all other asset classes is foreign exchange.

Traditional risk measures, the most popular and widely used in the literature, are considered for measuring the risk of assets. The first risk measure, standard deviation, represents Markowitz's classical approach. Considering that observed assets have non-normal distribution, our second and third choices are Value at Risk (VaR) and Conditional Value at Risk (CVaR). According to the fundamental Value at Risk definition, it is the maximum expected potential loss of a portfolio over a given time horizon for a given confidence interval under normal market conditions (Jorion, 2007). The Conditional Value at Risk, introduced by Rockafellar et al. (2000), quantifies the expected losses that occur beyond the VaR breakpoint. Three key elements are characteristic of both measures: time (period), confidence interval, and the specified amount of loss in value or percentage. Mathematical formulations of these three risk measures are given as follows:

$$StD(X) = \|X - E(X)\|_2 ,\tag{1}$$

$$VaR_\alpha(X) = \min\{-z : F_X(z) \geq \alpha\} = -F_X^{-1}(\alpha) ,\tag{2}$$

$$CVaR^-_\alpha(X) = E(-X : X \leq F_X^{-1}(\alpha)) ,\tag{3}$$

where $E(X)$ stands for the average return of the asset, α represents the confidence level, and $F_X(z)$ stands for the cumulative distribution function of the daily returns.

For analysis, we also use the Sharpe ratio that measures excess portfolio return over the risk-free rate R_f, relative to its standard deviation:

$$Sharpe\ ratio = \frac{E(R) - R_f}{StD(R)} .\tag{4}$$

Results and Discussion

The calculations are based on the historical data of assets' close prices. More precisely, for the observed period of January 2017 to November 2021, using the rolling window of daily returns for working days, for 126 days with the shift of 21 days, standard deviations, VaR, CVaR, and the Sharpe ratio are calculated. VaR and CVaR are calculated for 90% and 95% significant levels. The total number of calculations in the observed period is 52 per measure. The results are presented in Figures 1-6.
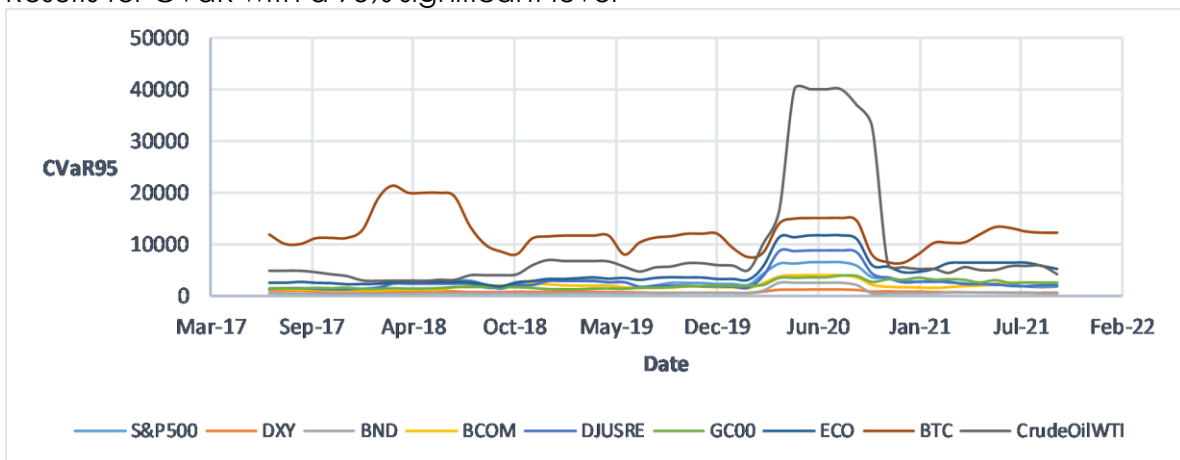
Figure 1
Results for standard deviation
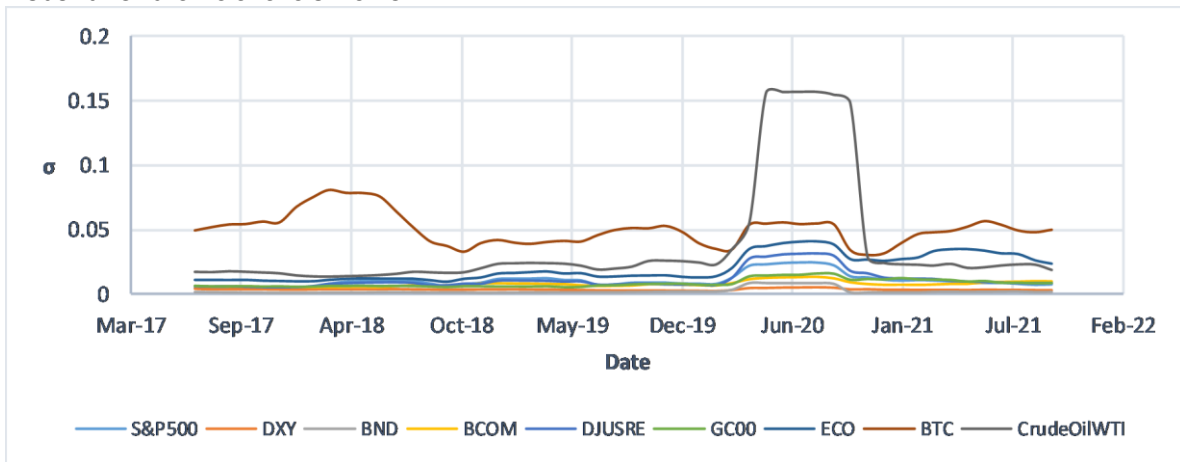
Source: The author's work in Excel.

Figure 2
Results for VaR with a 95% significant level

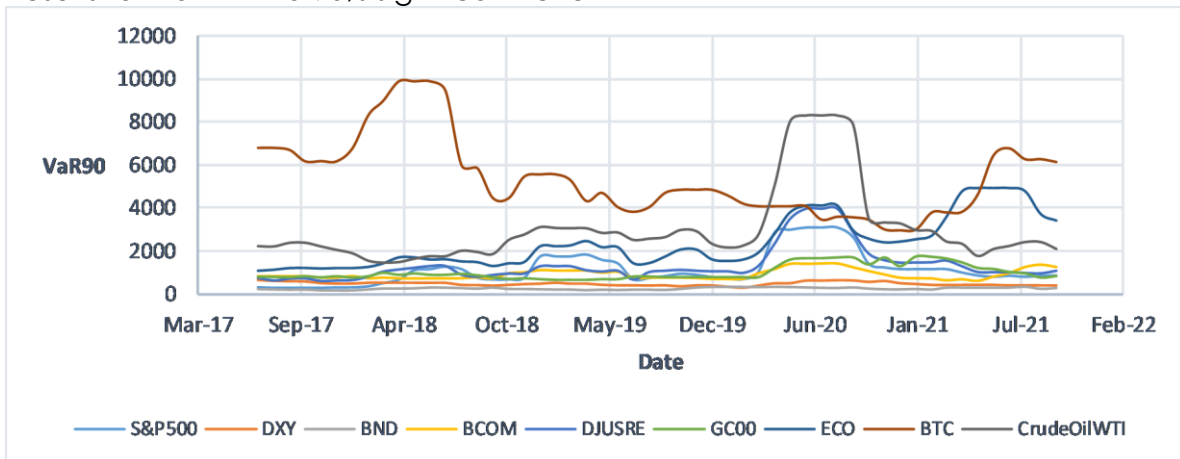

Source: The author's work in Excel.

Figure 3
Results for CVaR with a 95% significant level

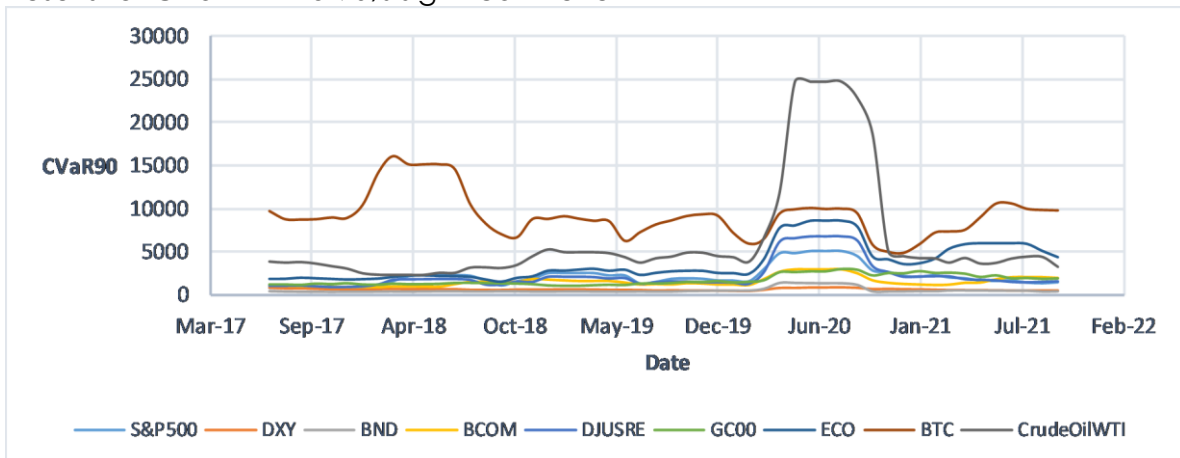*Source:* The author's work in Excel.

Figure 4
Results for VaR with a 90% significant level
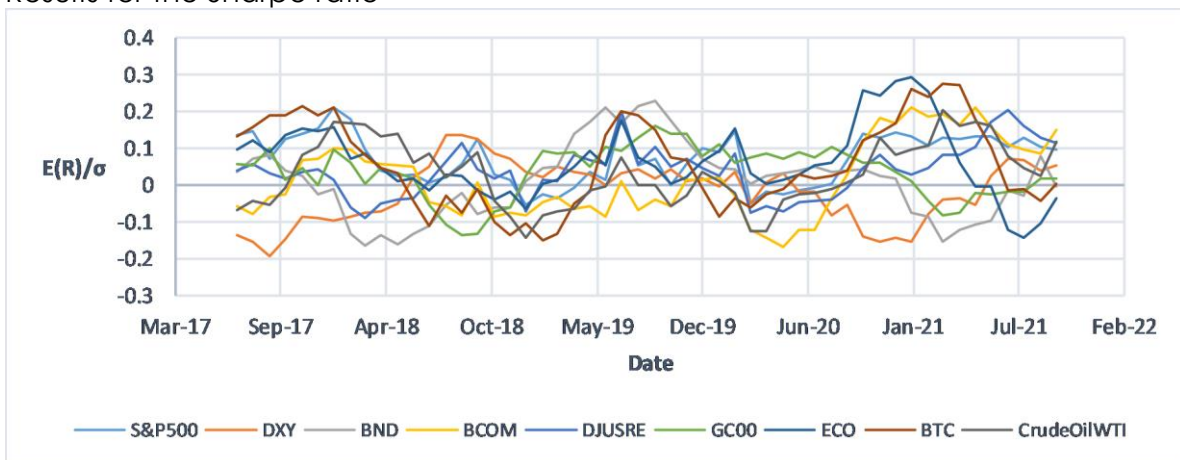

Source: The author's work in Excel.

Figure 5
Results for CVaR with a 90% significant level

Source: The author's work in Excel.

Figure 6
Results for the Sharpe ratio

Source: The author's work in Excel.

Figures 1-5 show that, regarding all risk measures, almost all assets had an increased level of risk between March 2020 and October 2020, which is the period of the onset of the pandemic crisis. In that period, crude oil had the largest risk values, while Bitcoin and the ECO index took the second worst position regarding risk measures. Out of that period, the largest risks are connected with Bitcoin, then with crude oil, and lately with renewable energy sources. If we look at Figure 6, the risk taken by investing in Bitcoin and renewable energy sources was periodically extremely well rewarded, which cannot be said so convincingly for crude oil. In addition to estimated risk values, it is important to observe the impact of the crisis on the riskiness of assets by observing the differences in the increase in risk values at the onset of the crisis compared to the period before the crisis. Thus, the highest increase in risk at the onset of the crisis, compared to the entire observed period before the crisis, was experienced by crude oil (WTI), renewable energy sources (ECO), real estate (DJUSRE), and stocks (S&P 500). Commodities (BCOM) and gold (GC00) have a relatively small increase in riskiness caused by the crisis.

In contrast, the riskiness of bonds (BND) and foreign exchange (USDX) is almost unaffected by the crisis. Bitcoin has a different risk trend concerning the remaining assets, whose highest risk value in the crisis did not exceed the highest risk value in the pre-crisis period. Although the risk rate increased during 2020 compared to the very end of 2019, this change in riskiness is not significantly different from the changes during the pre-crisis year of 2019. Therefore, although Bitcoin is among the first three riskiest assets in the crisis, it can be said that the crisis itself almost did not affect its increase in riskiness.

In addition to the individual analysis of the impact of the crisis on the risk of each asset class, it is interesting to analyze the mutual order of the observed types of assets regarding risk. Therefore, assets are ranked according to the average of 52 values for each of the five risk measures and the Sharpe ratio performance. Table 4 shows the ranks of nine different assets according to different measures and according to the entire observed period.

Table 4
Assets are ranked considering different measures from January 2017 to November 2021.

	VaR 95%	CVaR 95%	σ	VaR 90%	CVaR 90%	E(R)/σ
S&P500	5	5	5	5	5	9
DXY	8	8	8	8	8	1
BND	9	9	9	9	9	2
BCOM	7	7	7	7	7	3
DJUSRE	4	4	4	4	4	6
GC00	6	6	6	6	6	5
ECO	3	3	3	3	3	8
BTC	1	1	1	1	1	7
WTI	2	2	2	2	2	4

Note: In the case of standard deviation, VaR and CVaR rank 9 indicate the lowest risk level, while in the case of the Sharp ratio, rank 9 indicates the best proportion of expected return and risk.
Source: The author's calculations in MATLAB.

The results in Table 4 show that different risk measures rank assets equally according to their risk. Asset classes with a high average deviation from the mean (standard deviation) also have a high VaR and CVaR. Bitcoin has the highest risk level for all risk measures, but a good proportion of expected return and risk is presented with the

Sharp ratio. A similar and even slightly better situation is found with the ECO index. At the same time, crude oil is a risky asset, remaining a not very attractive investment regarding values, i.e., its rank by the Sharpe ratio. Bonds, the US Dollar Index, and commodities have the lowest levels of risk but also the lowest earning potential. Gold and Real Estate Index occupy the mid-ranks regarding observed risk values and the Sharpe ratio. Surprisingly, the best value from the Sharp ratio is found in stocks, which are accompanied by a middle level of risk and make them the most favourable asset.

Given that the observed period includes the period of the pandemic crisis in which the risk of almost all assets has increased, it is interesting to observe the results separately for the pre-and-crisis periods. Accordingly, a special ranking was conducted for pre-crisis data and data during the crisis, shown in Table 5 and Table 6. In addition, for easier analysis of the impact of the crisis on the mutual order of assets regarding riskiness and earning potential, Table 7 is given.

Table 5
Assets are ranked considering different measures from January 2017 to December 2019 (pre-crisis period)

	VaR 95%	CVaR 95%	σ	VaR 90%	CVaR 90%	E(R)/σ
S&P500	4	4	4	5	4	9
USDX	8	8	8	8	8	2
BND	9	9	9	9	9	4
BCOM	6	6	7	6	6	1
DJUSRE	5	5	5	4	5	5
GC00	7	7	6	7	7	6
ECO	3	3	3	3	3	8
BTC	1	1	1	1	1	7
WTI	2	2	2	2	2	3

Note: In the case of standard deviation, VaR and CVar rank 9 indicates the lowest risk level, while in the case of the Sharp ratio, rank 9 indicates the best proportion of expected return and risk.
Source: The author's calculations in MATLAB.

Table 6
Ranking assets considering different measures from January 2020 to November 2021 (crisis period)

	VaR 95%	CVaR 95%	σ	VaR 90%	CVaR 90%	E(R)/σ
S&P500	5	5	5	5	5	9
USDX	8	9	9	8	9	1
BND	9	8	8	9	8	2
BCOM	7	7	7	7	7	6
DJUSRE	4	4	4	4	4	5
GC00	6	6	6	6	6	3
ECO	3	3	3	3	3	8
BTC	1	2	2	1	2	7
WTI	2	1	1	2	1	4

Note: In the case of standard deviation, VaR and CVar rank 9 indicates the lowest risk level, while in the case of the Sharp ratio, rank 9 indicates the best proportion of expected return and risk.
Source: The author's calculations in MATLAB.

Table 7
Comparison of assets ranking according to risk before the crisis and risk during the crisis

Rank	Risk before crisis	Risk during crisis	Earning potential before the crisis	Earning potential during the crisis
9	BND	USDX	S&P500	S&P500
8	USDX	BND	ECO	ECO
7	GC00	BCOM	BTC	BTC
6	BCOM	GC00	GC00	BCOM
5	DJUSRE	S&P500	DJUSRE	DJUSRE
4	S&P500	DJUSRE	BND	WTI
3	ECO	ECO	WTI	GC00
2	WTI	BTC	USDX	BND
1	BTC	WTI	BCOM	USDX

Note: Rank 9 indicates the lowest risk level and highest earning potential.
Source: The author's calculations.

Tables 5-7 show that the COVID-19 crisis has affected ranks differently, i.e., risks and the return over risk ratio of some assets. Commodities (BCOM) keep their lower levels of risk in both periods, but with a significantly large difference in the Sharpe ratio ranking from the worst in the pre-crisis period to the fourth best in the crisis period. A significant impact is also obvious for gold (GC00). In the crisis, it became a slightly riskier asset and a less attractive investment regarding earning potential. From the fourth-best position in the Sharpe ratio ranking in the pre-crisis period, it sank to the third worst in the COVID-19 period. Due to the "episode" of high returns in the mid of 2019, bonds (BND) took a mid-position regarding the Sharpe ratio in the period before the crisis. For the crisis period, despite constant low-risk levels, they remained at the bottom of the Sharpe ratio ranking, together with the US Dollar Index (USDX). There were no changes in Sharpe ratio rank for the Real Estate Index (DJUSRE), although a slight risk increase happened. The always-risky Bitcoin (BTC) gains a slightly better risk rank position in the crisis period, with a consistently good expected return and risk ratio. The crisis did not affect the ECO Index rank positions at all. It stays a rather risky but profitable investment despite the spotted highest risk values during the first quarter of the COVID-19 crisis and worse risk rankings in the crisis period, the position of crude oil (WTI) regarding the Sharpe ratio improved by one place. Thus, crude oil was one place ahead of gold during the crisis.

Finally, stocks (S&P500) constantly have the best value of the Sharp ratio, accompanied by acceptable risk levels and a better risk ranking in the crisis period. This finding is surprising if we consider the results of recent studies, which had shown the priority of some other assets, primarily cryptocurrencies, in the observed context. Although stocks stayed trapped in the bear market for some time in 2020, it seems that stocks recovered very well over time and came to occupy a favourable position.

Conclusion

The presented research fulfilled the goal of risk measurement and comparing a wider set of different assets and asset groups. Risk is placed concerning the observed returns, thus indicating earning potentials of observed investments. In particular, the COVID-19 impact is considered. The study's possible limitation is that each asset class's representatives were chosen according to data availability. So, they are not necessarily the best representatives of classes. There are some interesting results from this study in which earning potentials are observed in parallel with risks. From the analysis of the individual impact of the crisis on the increasing risk levels of the different assets, it can be concluded that the crisis had the highest impact on the risk of crude

oil, renewable energy sources, real estate, and stocks, a slightly lower impact on the risk of commodities and gold, and a very low (almost none) impact on the risk of bonds, foreign exchange, as well as cryptocurrencies.

Although the crisis had a different impact on the riskiness of certain assets, it is interesting that the order of assets regarding risk did not change significantly during the crisis compared to the order before the crisis. In contrast, the order of assets regarding earning potential during the crisis, compared to the period before the crisis, changed significantly for commodities, from assets with the lowest earning potential to assets with the fourth-best earning potential. The crisis negatively affected the earning potentials of two more assets, gold and bonds. Surprisingly, and not in line with previous research, good old stocks won against all other assets and asset groups as the best-positioned asset according to earning potential before and during the crisis while having a middle level of riskiness. Furthermore, the study has shown the good features of a new alternative investment – renewable energy sources – with its second-best earning potential. On the third place on the list of earning potential is a new star on investors' horizon – cryptocurrencies.

The fact that most asset classes are low correlated, together with some specific correlation results, can be significant for investors. With the proper methodology, exploring the observed assets' diversifying, hedging, and/or safe-haven properties might be useful now that the crisis has continued.

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