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ARE GREEN CRYPTOCURRENCIES SAFE? INVESTIGATION OF THE GREEN AND NON-GREEN CRYPTOCURRENCIES

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Abstract

Cryptocurrencies, which started with Bitcoin, which was released differently from traditional payment and investment tools, have large transaction volumes today. In addition to the many economic benefits of cryptocurrencies, which are used both as a payment tool and as a financial investment tool, high energy consumption and a heavy carbon footprint come with them. With the owner of the automaker Tesla stating that he is worried about the increasing use of fossil fuels in Bitcoin mining and cutting its support for Bitcoin, the price of Bitcoin has fallen sharply, while green cryptocurrencies have reached historical peaks. This situation reminded the investors that they should handle risky investments carefully and also highlighted the importance of green investment tools. Understanding the relationship between green cryptocurrencies and other assets is essential for investors looking to expand their portfolios and seize emerging opportunities. In this direction, the study examined whether green cryptocurrencies are a safe haven against non-green cryptocurrencies in the period of January 2022–July 2023. In the analysis, DCC-GARCH analysis, risk, and return analyses were performed for safe haven. According to the analysis' findings, among cryptocurrencies, green cryptocurrencies are most likely to be a safe haven for investors.

Keywords: Green cryptocurrencies, Cryptocurrencies, DCC-GARCH, Risk-Return

Jel Codes: F65, G1, Q50.

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1. Introduction

Financial systems and, consequently, financial markets have undergone tremendous transformation at the same time as technology. Digital assets also take the stage in financial markets alongside traditional investment tools. Since the launch of the first cryptocurrency, Bitcoin, the cryptocurrency market has begun to attract increasing attention. As of October 2023, there are 8943 types of cryptocurrencies with a value of over $1 trillion in the global cryptocurrency market (Coinmarketcap, 2023). They attract more and more attention from investors day by day for many reasons, such as rapid price changes, the volatility they create in the markets and their speculative usage characteristics, and the fact that they do not have financial or corporate risks (Pham, Karim, Naeem, & Long, 2022). In addition, cryptocurrencies can be legally preferred as a means of payment in South American countries such as Paraguay, Argentina, and Uruguay, especially El Salvador (Tradingview, 2023). Therefore, cryptocurrencies are considered both a payment tool and an investment tool.

In crypto mining, a software system based on cryptographic principles and mathematical algorithms is used to change the hands of digital currencies and monitor their records. Depending on the complexity of the password that needs to be solved in cryptocurrencies and the abundance of calculations required to verify the transactions made, a high amount of computer power and therefore energy consumption is required in cryptocurrency mining. For this reason, in addition to its many economic benefits, the energy consumption and carbon emissions during crypto mining are quite high (Pham et al., 2022). For a single Bitcoin transaction, 2143.01 kWh of electricity is consumed, which is equivalent to 496.29 days of electricity consumption for an average Turkish household and the annual electricity consumption of countries such as Thailand and Kazakhstan (TUIK, 2023; Vries, 2019; Digiconomist, 2022; Pham et al., 2022; Arfaoui, Naeem, Boubaker, Mirza, & Karim, 2023). This energy consumption is also equivalent to 2,257,087 VISA transactions and causes 1017.93 kg of carbon emissions (Digiconomist, 2022; Pham et al., 2022; Arfaoui et al., 2023).

As a result of the exacerbation of the impact of environmental pollution on climate change as a result of carbon emissions resulting from high fossil fuel and energy use, the 21st UN Climate Change Conference of the Parties (COP21) was held, and with the signed Paris Agreement, a consensus was reached on the creation of a stable financing flow to ensure low carbon gas emissions. Approaches to financing projects planned to be carried out in a wide range of sectors for the purpose of protecting the environment and reducing the effects of climate change have also formed the basis for the development of the concept of sustainable

finance (Robbins, 2016; Rhodes, 2016). Green financing tools, one of the elements of sustainable finance, are frequently preferred by governments, financial institutions, and investors for the use of environmentally beneficial or less harmful products and the implementation of projects (Kuloğlu & Öncel, 2015). Today, cryptocurrencies, which come to the fore with the influence of technology and cause high carbon gas emissions, are also on their way to becoming green financial assets. So much so that the Crypto Climate Pact, launched in April 2021, a privately led movement dedicated to making the cryptocurrency industry fully renewable, was established in response to growing concerns about the environmental impacts of cryptocurrencies (Cryptoclimate, 2023). The agreement aims to achieve this by working collaboratively with the cryptocurrency industry, including all blockchains, to switch entirely to renewable energy by 2025 or sooner (Cryptoclimate, 2023). Thus, a new class of sustainable cryptocurrencies, namely green cryptocurrencies, has emerged, and as of October 2023, there are 40 million green tokens in circulation (Energyfi, 2023).

The percentage of Bitcoin in the total transaction volume in the cryptocurrency market varies between 70–95% in 2020, 40–44% in 2022, and 37–52% in 2023. Bitcoin is followed by Ethereum, and Ripple in total transaction volume (Coinmarketcap, 2023). Since the significant increases in Bitcoin prices in recent years have increased demand, investors have turned to the production of completely new cryptocurrencies. Therefore, with the increasing popularity of cryptocurrencies, the increase in demand for cryptocurrencies also increases the energy consumption for cryptocurrency production (Corbet, Lucey, & Yarovaya, 2021). Environmental concerns brought about by cryptocurrency mining have forced investors to choose between benefiting economically by investing in cryptocurrencies or turning to green cryptocurrencies to diversify climate and environmental risks (Naeem & Karim, 2021; O'Dwyer & Malone, 2013; McCook, 2015; Hayes, 2017; Vranken, 2017; Bevand, 2018; Krause & Tolaymat, 2018; Kumar, 2021; Pham et al., 2022). However, the reasons that direct investors to green cryptocurrencies are not limited to climate and environmental risks. In addition, social and corporate governance risks are among the factors that cause investors to turn to digital green products rather than traditional products within the scope of green finance.

The recent suspension of cryptocurrencies in Tesla's purchasing policy has raised concerns about the sustainability of cryptocurrencies for investors and policymakers (Arfaoui et al., 2023). The sharp 14% drop in Bitcoin price that occurred as a result of this situation reminded investors that they should carefully evaluate riskier investments (Naeem & Karim, 2021). Therefore, understanding the relationship between green cryptocurrencies and other

assets is crucial for investors aiming to expand their portfolios and seize emerging opportunities. In this regard, it is aimed at examining the safe haven against green and non-green cryptocurrencies in the cryptocurrency market. For this, the period between January 2022 and July 2023, when common data on variables could be accessed during the Crypto Climate Agreement process, was taken into account. In the analysis, DCC-GARCH risk and return analysis, which is frequently preferred in the literature for safe haven analysis, was performed. Thus, it was interpreted whether green cryptocurrencies were a safe haven among other cryptocurrencies for sudden price changes. Unlike the studies in the literature, this study, which was analyzed by taking into account non-green cryptocurrencies other than Bitcoin, also revealed whether green cryptocurrencies produced to protect the environment protect investors from a possible digital-based crisis.

The organisation of this study is as follows: The literature review and the framework were introduced in the first two sections of this study. The variables of the dataset investigated in the research are provided in depth in the third part. After the data information, the research methods and conclusions are presented. The paper's conclusion is provided in the final part.

2. Literature Overview

Drawing attention with its advantageous features and benefits, Bitcoin also draws attention with its environmental effects due to its dependence on energy consumption during the production phase (Köhler & Pizzol, 2019; Schinckus, Nguyen, & Ling, 2020; Jana, Ghosh, Das, & Dutta, 2021; Roeck & Drennen, 2022; Miśkiewicz, Matan, & Karnowski, 2022). Using the temperature projection prediction model, Mora, Rollins, Taladay, Kantar, Chock, Shimada, & Franklin (2018) found that the use of Bitcoin alone emits enough carbon to increase global warming above 2°C in less than three decades. Mohsin, Naseem, Zia-ur-Rehman, Baig, & Salamat (2020) researched the empirical effects of cryptocurrency volume, GDP, and energy use upon environmental sustainability. According to the error correction model they applied, they obtained a bidirectional causal relationship between the volume of cryptocurrencies and environmental degradation in the short and long term. Di Febo, Ortolano, Foglia, Leone, & Angelini (2021) examined the tail relationship between the carbon credit market and Bitcoin price with the MVQM-CAViaR Model and Granger Causality Test. They concluded that Bitcoin diffusion has a strong impact on the carbon credit market.

In order to cope with the climate crisis, green financial investment tools such as green bonds, green coins, and sustainability indexes have been created. When studies on green financial investment tools are examined, it shows that green investment tools have a positive

effect on protecting traditional investors (Bouri, Iqbal, & Klein, 2022). Ren & Lucey (2021) examined whether clean energy cryptocurrencies, namely green coins, are a haven for investors. They pointed out that clean energy is more likely than green energy to serve as a safe haven for filthy cryptocurrencies during this period of increased uncertainty. Naeem & Karim (2021) examined the multi-tail dependency regimes that characterise the overdependence between green financial assets and Bitcoin and observed that the dependency structure was mainly asymmetrical and changed over time. Patel, Kumar, Bouri, & Iqbal (2023) examined the contagions between green and dirty cryptocurrencies and socially responsible investments during the war in Ukraine. They observed that the size of the contagions and the respective roles of each cryptocurrency and socially responsible investment evolved during the war. They noted that Ethereum has consistently played an important role in the transmission of returns and volatility shocks. Pham et al. (2022) investigated the tail dependence between carbon prices and green and non-green cryptocurrencies in the period from 2017 to 2021. They found that green cryptocurrencies have a loose relationship with Ethereum and Bitcoin. Arfaoui et al. (2023) used a network approach to investigate the connections between cryptocurrency, green markets, and sustainable energy. They discover that green bonds have the least financial market integration. This result demonstrates how crucial a part it plays in giving investors the advantages of diversity.

From the perspective of cryptocurrencies, understanding the relationship between green cryptocurrencies and non-green cryptocurrencies is very important for both policymakers and investors who aim to capture the opportunities in digital assets. It allows policymakers to create appropriate mechanisms and policies to reduce the negative effects of contagion, especially during extreme-risk events. In this regard, the relationship between green and non-green cryptocurrencies is examined in the next section.

3. Data, Methodology and Empirical Results

Cryptocurrencies and the amount of energy they consume are studied by most researchers (O'Dwyer & Malone, 2013; McCook, 2015; Hayes, 2017; Vranken, 2017; Bevand, 2018; Krause & Tolaymat, 2018; Kumar, 2021). Instead of an energy-intensive proof-of-work (PoW) system, green cryptocurrencies adopt a non-energy proof-of-stake (PoS) system, the Ripple Protocol, the Stellar Protocol, and some other alternative energy-efficient consensus algorithms. The cryptocurrencies with the largest market value using the PoW system are Bitcoin, Dogecoin, and Litecoin. Accordingly, in the study, while Bitcoin (BTC), Dogecoin (DOGE), and Litecoin (LTC) were selected as non-green cryptocurrencies, Ripple (XRP), Stellar (XLM),

and Chia (XCH) were selected as green cryptocurrency samples. The relationships of the selected green and non-green cryptocurrencies in the period January 2022–July 2023, where common data on the variables can be accessed during the crypto agreement climate process, were examined with DCC-GARCH risk and return analysis, and it was interpreted whether they were safe havens. The graphs of the daily return series of the variables used are given in Figure1.

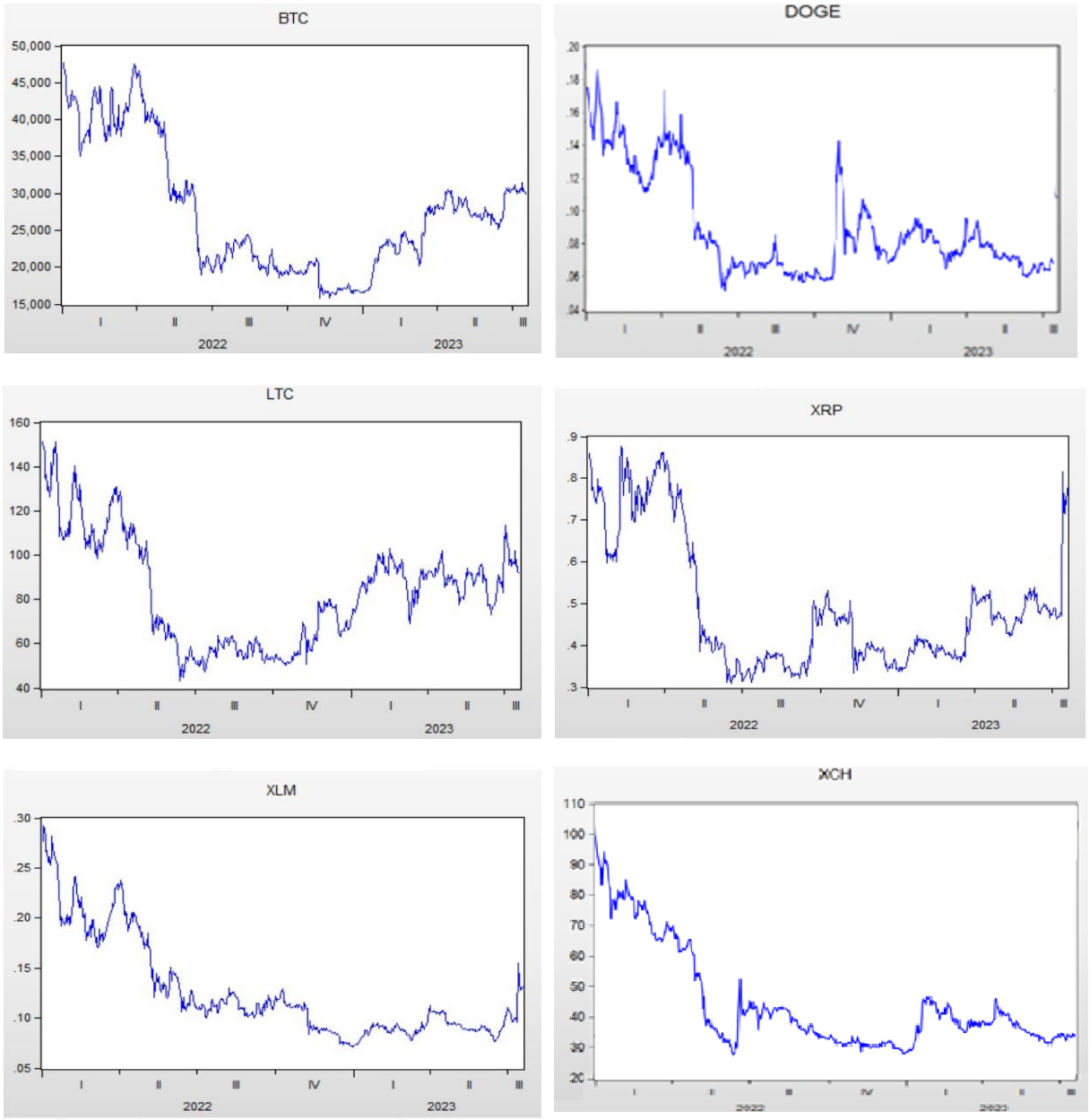

Figure 1:

Changes in Returns of Variables

Source: Created by the authors with data from Investing (2023).

The descriptive statistics of the returns of the cryptocurrencies used in the analysis are given in Table 1.

Table 1.
Descriptive Statistics

	BTC	DOGE	LTC	XRP	XLM	XCH
Mean	27381.61	0.09	83.29	0.49	0.12	45.00
Median	25917.60	0.07	84.02	0.44	0.10	38.39
Max	47738.00	0.18	151.20	0.87	0.29	104.10
Min	15776.20	0.05	43.40	0.30	0.07	27.99
Std. Dev.	8548.37	0.03	24.15	0.15	0.04	17.00
Skewness	0.69	1.11	0.48	1.03	1.31	1.43
Kurtosis	2.35	3.04	2.56	2.78	3.74	3.92
Jarque-Bera	55.44*	116.34*	26.32*	102.45*	174.55*	213.25*
ADF	-2.37*	-1.65*	-2.89**	-2.06**	-3.06**	-3.44*

Note: * and ** indicate that the level of significance is 1% and 5%, respectively.

When the statistics in Table 1 are examined, all return series are stationary according to the Augmented Dickey-Fuller test shown with ADF. According to the Jarque-Bera test of normality, all return series do not show a normal distribution.

In order to interpret whether green cryptocurrencies are a safe zone or not, the relationship between green cryptocurrencies and non-green cryptocurrencies was examined with Engle's (2005) Dynamic Conditional Correlation (DCC-GARCH) model. The reason why the DCC-GARCH model is preferred is that the conditional correlations between cryptocurrencies are not realistic and change over time. The method used by Capie, Mills, & Wood (2005), Baur & McDermott (2010), and Baur & Lucey (2010) is followed in the study. In this context, the regression model is as in Eq.1.

$$r_{green,t} = a + b_1 r_{BTC,t} + b_2 r_{BTC,t(q)} + c_1 r_{DOGE,t} + c_2 r_{DOGE,t(q)} + d_1 r_{LTC,t} + d_2 r_{LTC,t(q)} + e_t \quad (1)$$

Here green=XRP, XLM, and XCH.

$r_{BTC,t}$ $r_{DOGE,t}$ and $r_{LTC,t}$ are the Bitcoin, Dogecoin, and Litecoin returns, respectively; e_t is the error term; a, b_1, b_2, c_1, c_2, d_1, d_2 represent the estimated parameters. $r_{BTC,t(q)}$, $r_{DOGE,t(q)}$, and $r_{LTC,t(q)}$ are included in the model to explain positive or negative asymmetric shocks and focus on the returns of falling non-green coins. In order to analyse the role of green cryptocurrencies in times of crisis, non-green cryptocurrencies at the lowest 5%, 2.5%, and 1% (q%) are included in the analysis.

The regression model in Eq. 1, which expresses the simultaneous measurement of the effects of non-green cryptocurrency returns on green cryptocurrency returns, is static. In the regression model, it is possible to make dynamic measurements by taking into account the lagged effects (Baur & Lucey, 2010). The dynamic state of the static model in Eq.1 is given in Eq. 2.

$$r_{green,t} = a + \sum b_{0(1)} r_{green(t-1)} + \sum b_{1(1)} r_{BTC(t-1)} + \sum b_{2(1)} r_{BTC(t-1,q)} + \\ + \sum c_{1(1)} r_{DOGE(t-1)} + \sum c_{2(1)} r_{DOGE(t-1,q)} + \sum d_{1(1)} r_{LTC(t-1)} + \sum d_{2(1)} r_{LTC(t-1,q)} + e_t \quad (2)$$

Here green=XRP, XLM, and XCH.

Accordingly, the GARCH analysis and estimation results are given in Table 2.

Table 2.
GARCH Analysis Results

XRP	Coefficient	Std. Error	Z Statistic
r_{BTC}	0.001	0.000	72.179*
$r_{BTC}(5\%)$	0.001	0.000	42.340*
$r_{BTC}(2.5\%)$	0.001	0.000	25.456*
$r_{BTC}(1\%)$	0.001	0.000	18.897*
r_{DOGE}	0.444	0.041	10.624*
$r_{DOGE}(5\%)$	0.444	0.041	11.342*
$r_{DOGE}(2.5\%)$	0.444	0.041	10.936*
$r_{DOGE}(1\%)$	1.045	0.116	9.014*
r_{LTC}	0.001	0.004	38.840
$r_{LTC}(5\%)$	0.001	0.004	27.870
$r_{LTC}(2.5\%)$	0.001	0.003	8.567
$r_{LTC}(1\%)$	0.000	0.000	1.045
Wald Test	101.65*		
XLM	Coefficient	Std. Error	Z Statistic
r_{BTC}	0.000	0.000	101.953*
$r_{BTC}(5\%)$	0.000	0.000	107.354*
$r_{BTC}(2.5\%)$	0.000	0.000	54.358*
$r_{BTC}(1\%)$	0.000	0.000	123.011*
r_{DOGE}	0.690	0.013	52.351*
$r_{DOGE}(5\%)$	0.772	0.015	48.524*
$r_{DOGE}(2.5\%)$	1.073	0.015	70.986*
$r_{DOGE}(1\%)$	0.811	0.011	70.011*
r_{LTC}	-0.000	0.001	-47.033*
$r_{LTC}(5\%)$	-0.001	0.001	-67.812*
$r_{LTC}(2.5\%)$	-0.000	0.001	-56.758*
$r_{LTC}(1\%)$	-0.000	0.001	-62.693*
Wald Test	66.631*		
XCH	Coefficient	Std. Error	Z Statistic
r_{BTC}	0.000	0.001	40.971*
$r_{BTC}(5\%)$	0.000	0.000	93.737*
$r_{BTC}(2.5\%)$	0.000	0.001	48.034*
$r_{BTC}(1\%)$	0.000	0.002	32.819*
r_{DOGE}	312.757	4.231	73.914*
$r_{DOGE}(5\%)$	305.558	3.419	89.355*
$r_{DOGE}(2.5\%)$	320.388	5.242	61.108*
$r_{DOGE}(1\%)$	220.834	5.753	38.385*
r_{LTC}	-0.055	0.004	-11.587*
$r_{LTC}(5\%)$	-0.074	0.003	-22.282*
$r_{LTC}(2.5\%)$	-0.066	0.005	-11.776*
$r_{LTC}(1\%)$	-0.003	0.009	-0.331
Wald Test	46.519*		

Note: * indicate that the significance level is 1%.

When Table 2 is examined, it is understood that Ripple does not have the feature of being a safe haven. However, Stellar is hedging on average in terms of Litecoin, and at the same time, it is a safe haven for negative stock returns, with tranches of 5%, 2.5%, and 1%. Chia appears to be an average hedging option for Litecoin and also a safe haven for extremely negative returns, with tranches of 5% and 2.5%.

In order to interpret whether green cryptocurrencies are a safe haven, a risk and return analysis was performed as a second step. In the calculation of the returns, the formula obtained by dividing the value in the current period and the value difference in the previous period by the value in the previous period is used. The formula of the return is mathematically expressed by Eq. (3), where the return is R, the return in the t period is R_t, the return in the t-1 period is R_{t-1}.

$$R = \frac{R_t - R_{t-1}}{R_{t-1}} \tag{3}$$

The risk-adjusted rate of return, which is an important indicator for investors in addition to risk and return, is formulated with equation (4), where ψ is the Sharpe ratio, i is the risk-free interest rate, R is the return, and σ is the standard deviation of the investment tool.

$$\psi = \frac{R - i}{\sigma} \tag{4}$$

In the light of given formulas (3) and (4), the risk-return values calculated for Bitcoin, Dogecoin, Litecoin, Ripple, Stellar and Chia are given in Table 3.

Table 3.
Risk and Return Analysis Results for the Safe Haven Analysis of Green Cryptocurrencies

	Return		Risk-Adjusted Return	
	Return (%)	Rank	Sharpe Ratio (%)	Rank
BTC	-0.035	4	-0.000	1
DOGE	-0.039	5	-3.346	6
LTC	0.009	2	-0.004	2
XRP	0.111	1	-0.659	4
XLM	-0.006	3	-2.501	5
XCH	-0.142	6	-0.005	3

When Table 3 is examined, it is seen that the cryptocurrency with the highest return according to risk is Litecoin, Ripple, and Stealler, respectively. The average return of green cryptocurrencies is -0.01%, while the average return of non-green cryptocurrencies is -0.02%. Similarly, when the average of the risk-adjusted returns is taken, -105.55% for green cryptocurrencies and -111.68% for non-green cryptocurrencies are obtained. The risk-adjusted rate of return is preferred by investors as it deals with both risk and return. The higher the

Sharpe ratio, the better the return on investment for the risk. Accordingly, green cryptocurrencies are leading in risk-adjusted returns. In other words, green cryptocurrencies have relatively higher returns.

4. Conclusion

The process that started with Bitcoin, which was launched in 2009 as a different traditional payment and investment tool, has formed the basis of the crypto money market with large transaction volumes today. So much so that, as of October 2023, there are 8943 types of cryptocurrencies with a value of over $1 trillion in the global cryptocurrency market (Coinmarketcap, 2023). In addition to the many economic benefits of cryptocurrencies, which are used both as a payment tool and as a financial investment tool, they also have high energy consumption and a heavy carbon footprint. Despite their substantial carbon dioxide emissions, cryptocurrencies are working towards becoming green financial assets.

Many cryptocurrencies, especially Bitcoin, lost value after the owner of the automaker Tesla stated that he was worried about the increasing use of fossil fuels in Bitcoin mining and that he had stopped supporting Bitcoin. In the same period, some green cryptocurrencies, which were at their lowest price, multiplied their values and reached the top. Additionally, this sharp drop in the price of Bitcoin reminded investors to carefully consider riskier investments. Understanding the relationship between green cryptocurrencies and other assets has proven to be very important for investors looking to expand their portfolios and seize emerging opportunities. In this direction, it has been examined whether there is a safe haven against green cryptocurrencies and non-green cryptocurrencies in the crypto money market in the period of January 2022–July 2023.

A DCC-GARCH model proposed by Engle (2002), used by Baur and Lucey (2010), and Ren and Lucey (2022), was used to determine the safe haven. According to the analysis findings, Stellar is, on average, hedging against Litecoin and is also a safe haven for extremely negative all-yield tranches. Chia appears to be an average hedging option for Litecoin as well as a safe haven for extremely negative 5% and 2.5% yield tranches. From the point of view of Ripple, it does not have the feature of being a safe haven. This situation at Ripple supports the findings of Ren & Lucey (2022), who found that clean energy assets cannot yet an effective direct hedging tool for cryptocurrencies.

In addition to the DCC-GARCH analysis to determine whether green and non-green cryptocurrencies are safe havens, the risks and returns of cryptocurrencies are also examined.

The risk-adjusted rate of return is preferred by investors as it deals with both risk and return. The higher the Sharpe ratio, the better the return on investment for the risk. Green cryptocurrencies have higher risk-adjusted returns. Accordingly, green cryptocurrencies have higher risk-adjusted returns. Investors have both environmental and economic interests in adding green cryptocurrencies to their portfolios, as financial risks are low in addition to environmental risks.

Stellar and Chia provide average hedging against Litecoin. Thus, in general, it can be said that green cryptocurrencies are likely to be safe havens. Future studies can compare portfolios made up of green assets versus portfolios made up of non-green assets to draw clearer conclusions. Therefore, by diversifying the assets, the risks will also be diversified, providing the potential for general inference.

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