Are ESG indexes a safe-haven or hedging asset? Evidence from the COVID-19 pandemic in China

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Abstract

Purpose – The aim of the paper is to investigate the risk-hedging and/or safe haven properties of environmental, social and governance (ESG) index during the COVID-19 in China.
Design/methodology/approach – This paper employs the DCC, VCC, CCC as well as Newey–West estimator regression.
Findings – The findings provide empirical evidence of the risk hedging properties of ESG indexes as well as of the environmental, social and governance thematic indexes during the outbreak of the COVID-19 crisis. The results also support the superior risk hedging properties of ESG indexes over cryptocurrency. However, the authors do not find any safe haven properties of ESG, Bitcoin, gold and West Texas Intermediate (WTI).
Practical implications – The paper offers therefore, practical policy implications for asset managers, central bankers and investors suggesting the pandemic risk-hedging opportunities of ESG investments.
Originality/value – The study represents one of the first empirical contributions examining safe-haven and hedging properties of ESG indexes compared to traditional and innovative safe haven assets, during the eruption of the COVID-19 crisis.

Keywords ESG indexes, Bitcoin, COVID-19, Safe-haven investments, Risk hedging
Paper type Research paper

1. Introduction

Environmental, social and governance (ESG) investments – also called socially responsible investments – are those using a set of ESG alongside risk-return criteria, to select investments (Renneboog *et al.*, 2008). Negative ESG criteria are applied, for instance, when investment in controversial industries (e.g. those producing oil or tobacco) or poor ESG firms are excluded, while positive ESG criteria are applied when the investment in high ESG firms is realized. Another commonly used ESG strategy is the best in class that permits investments in companies with the highest ESG scores (Renneboog *et al.*, 2008; Sandberg, 2011). Similarly, thematic criteria concern the investments in a specific ESG issue or in high environmental or social or governance firms (Revelli and Viviani, 2015).

ESG funds, indexes and related exchange-traded funds (ETF) adopt one or more ESG strategies and target a broad field of ESG issues or a single issue, as it happens with the thematic environmental or corporate governance indexes (Henriques and Sadorsky, 2018).

ESG investments have experienced a fast transition from marginal to mainstream investments over the last few years (Global Sustainable Investment Alliance, 2019), however, a huge debate is still open on the financial utility of ESG investments in terms of portfolio performance and diversification (e.g. Renneboog *et al.*, 2008; Nofsinger and Varma, 2014;

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Auer and Schuhmacher, 2016; Lins *et al.*, 2017). While the field of study has experienced tremendous growth in recent years (Henriques and Sadorsky, 2018; Sabbaghi, 2020), little is also currently known about the volatility dynamics of ESG investments and the correlation between such types of investments and equity markets, or the correlation with relevant (safe-haven) assets, such as commodities (Andersson *et al.*, 2020; Iglesias-Casal *et al.*, 2020) or cryptocurrencies (Bouri *et al.*, 2017; Das *et al.*, 2020).

The COVID-19 pandemic represents a relevant exogenous event to study whether ESG investments show safe-haven properties and/or hedging properties. Following the approach of Baur and Lucey (2010), we aim to verify if ESG indexes are "uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil" (safe-haven) or "if they are uncorrelated or negatively correlated on average" over the time periods (Baur and Lucey, 2010 p. 219). Specifically, using the DCC GARCH (1,1) method (Corbet *et al.*, 2020; Onali, 2020; Zhong and Liu, 2021), our paper contributes to the search for safe-haven and hedging assets during the COVID-19 outbreak (e.g. Corbet *et al.*, 2020) investigating ESG indexes against conventional stock equity indexes and against two assets widely recognized as safe-havens: gold (Baur and Lucey, 2010; Baur and McDermott, 2010; Ciner *et al.*, 2013; Akhtaruzzaman *et al.*, 2021a, b) and West Texas Intermediate (WTI) (Corbet *et al.*, 2020). Our analysis also considers an emerging asset showing safe-haven properties, the Bitcoin (BTC) (Bouri *et al.*, 2017; Selmi *et al.*, 2018; Das *et al.*, 2020). Similarly, we investigate the safe-haven and risk hedging properties of Chinese ESG thematic indexes separately, to identify properties of the ESG pillars against the traditional (oil and gold) and innovative assets (BTC). For the purpose of this paper, we focus on the epicenter of COVID-19: the Chinese market (Zhang *et al.*, 2020). Investigation into the Chinese market is motivated by several reasons. First, while the literature on ESG investments widely assesses US and European ESG markets, the Chinese ESG market received relatively little attention over the years (Auer and Schuhmacher, 2016; Kao *et al.*, 2018; Gao *et al.*, 2020). China represents the most relevant emerging market (Rezaee *et al.*, 2020) and it is characterized by several peculiarities, such as the large influence of state ownership and the corporate governance setting (Ji *et al.*, 2017; Rezaee *et al.*, 2020).

Second, the Chinese ESG market is growing (Gao *et al.*, 2020) and it is experiencing political pressure aimed at reducing pollution and at increasing both firm responsibility and ESG disclosure (McGuinness *et al.*, 2017; Liao *et al.*, 2018; Wang *et al.*, 2018; Wei and Xiao, 2020). Finally, recent studies highlight Chinese institutional investor preference toward ESG investments given the long-term perspective of such types of assets (Gao *et al.*, 2020). Thus, our study may support investors' decisions over market shocks. The choice of testing the ESG indexes' relationship with traditional and innovative assets is justified by the absence of studies that combine these assets together, while several studies support their safe-haven and hedging properties. According to Selmi *et al.* (2018) both BTC and gold "may act as a safe-haven in uncertain periods but for different reasons. For Bitcoin, its limited supply and its increased popularity certainly elevate its value. For gold, however, investors and traders would often perceive it as a good hedge and a safe-haven against the fluctuations of various assets, which was traditionally its most common use. Thus, whatever the investor's goals are, both Bitcoin and gold can co-exist as refugees".

Our paper contributes to the literature on safe-haven assets in the COVID-19 pandemic (e.g. Corbet *et al.*, 2020; Goodell, 2020; Akhtaruzzaman *et al.*, 2021a, b) and the emergent literature on ESG investments over market shocks (e.g. Nofsinger and Varma, 2014; Broadstock *et al.*, 2020; Omura *et al.*, 2020; Akhtaruzzaman *et al.*, 2021a). Indeed, to the best of our knowledge, our work is the first empirically investigating the correlation between ESG investments, cryptocurrencies and the equity market. Similarly, we are the first that investigate the hedging and safe-haven properties of Chinese ESG thematic indexes, answering the need of assessing risk-hedging and safe-haven properties also of these types of innovative indexes that individually cover an ESG theme.

The remainder of the paper is structured as follows. Section 2 reviews the literature and poses the hypotheses of our work. Section 3 and 4 describe data and method, respectively, while Section 5 presents and discusses the main findings of the analysis. Finally, Section 6 presents the robustness tests and Section 7 concludes the paper.

2. Literature review

The performance of ESG investments represents a large field of study (Sabbaghi, 2020; Sturm and Field, 2018), with a growing interest in performance over turbulent times, such as financial crises (Nofsinger and Varma, 2014; Leite and Cortez, 2015; Lins *et al.*, 2017; Matallín-Sáez *et al.*, 2019; Lean and Pizzutilo, 2020) and market shocks (Nakai *et al.*, 2016; Omura *et al.*, 2020; Singh, 2020; Akhtaruzzaman *et al.*, 2021a). Supporters of ESG investments argue that a good commitment to ESG values provides an insurance role when bear market conditions occur (Bouslah *et al.*, 2018), thanks to the production of a sort of moral capital among firm stakeholders (Godfrey, 2005; Godfrey *et al.*, 2009) or a loyal relationship with stakeholders (Flammer, 2015). In other words, ESG investments, in contrast with the neoclassical theory supporting the negative financial impact of costs related to ESG compliance (Friedman, 1970) and ESG screening, reveal their competitive advantages (Porter and Kramer, 2006) and risk reduction attitude (Fatemi and Fooladi, 2013) over market shocks. In this vein, ESG investments may be considered as an alternative asset that can "help investors hedge and rebalance their portfolios" (Ameur *et al.*, 2020).

Findings around the performance of ESG investments over bear market conditions, however, are not conclusive and they are mostly obtained comparing ESG investments against traditional peers (Sturm and Field, 2018), such as low ESG engaged firms, conventional funds and parent indexes. A preference for ESG investments (Nofsinger and Varma, 2014; Nakai *et al.*, 2016) alternates with a substantial indifference in choosing ESG or traditional investments (Leite and Cortez, 2015; Lean and Pizzutilo, 2020).

The recent studies inspired by the COVID-19 pandemic are also inconclusive. Omura *et al.* (2020) show the outperformance of ESG indexes against their benchmarks, but they cannot conclude for the superior performance of ETFs. Other studies support the refuge role played by ESG investments (Singh, 2020) and a "relative resilience to financial risk" of Chinese firms showing high ESG engagement (Broadstock *et al.*, 2020).

The investigation across ESG indexes (Jawadi *et al.*, 2019; Lean and Pizzutilo, 2020; Omura *et al.*, 2020) and their safe-haven properties have also gained a new consideration in recent years. For instance, Jawadi *et al.* (2019) identify relevant spillovers between conventional and ESG indexes in the USA market while Umar *et al.* (2020) find that ESG indexes worldwide are broadly correlated, even over market shocks, thus the inclusion of other assets in a portfolio is desired to achieve diversification or the optimal hedge.

Other two recent studies (Ameur *et al.*, 2020; Andersson *et al.*, 2020) support the presence of risk spillovers between ESG and conventional markets (Ameur *et al.*, 2020) and a bidirectional causal relationship between ESG investments and both conventional and Islamic investments, though decreasing in the long-term (Andersson *et al.*, 2020). During the pandemic crisis, Rubbaniy *et al.* (2022) find evidence of ESG indexes' safe-have properties; however, the results are related to the different types of measures used for identifying the pandemic severity.

Gold and oil (or oil volatility index) represent good hedge assets for ESG investments (Andersson *et al.*, 2020; Iglesias-Casal *et al.*, 2020), while currencies do not show specific positive properties (Andersson *et al.*, 2020).

The ambiguities of previous findings on normal and turmoil periods and the missing link between ESG investments and the other safe-haven assets, suggest formulating alternative hypotheses that consider the possibility that ESG indexes work as safe-haven assets during

the worst market phases represented by the COVID-19 pandemic or that, although they cannot be considered a safe-haven, on average, they can be considered risk hedging assets, playing a sort of insurance role (Bouslah *et al.*, 2018; Ameur *et al.*, 2020). Thus, we formulate the following alternative hypotheses:

H1a. ESG investments are safe-haven assets, compared to gold, WTI and BTC

H1b. ESG investments are risk-hedging assets, compared to gold, WTI and BTC

ESG indexes select firms according to a set of ESG criteria (negative, positive and best in class) weighting de facto the environmental, social and governance components. The overall measure of ESG factors may, however, obfuscate the financial relevance of the single components (Chatterji *et al.*, 2009; Galema *et al.*, 2008; Godfrey *et al.*, 2009). For this reason, and also due to both the new social and environmental challenges, like climate change, and the high innovativeness of ESG products, such as the new green and social finance products, several studies separately analyze the performance of the ESG pillars or different ESG investment strategies (Muñoz *et al.*, 2014).

Good governance has been recognized as able to improve reputation (Nofsinger and Varma, 2014) and to protect firms when bear market conditions occur (Ducassy, 2013; Nofsinger and Varma, 2014; Leite and Cortez, 2015). Similarly, good environmental performance may protect firms when an environmental accident occurs (Flammer, 2013) and more generally, green assets (or green energies) are considered an alternative to fossil fuel assets: when the price of fossil fuel assets increases, the investments in green energy are incentivized due to a substitution effect between such green and fossil fuel assets (Ferrer *et al.*, 2018; Xia *et al.*, 2019).

At the country level, the recent studies by Capelle-Blancard *et al.* (2019) and Crifo *et al.* (2017) confirm that governance and social factors are negatively correlated with the spread of sovereign bonds. Studies on environmental funds support findings of mixed performance (Climent and Soriano, 2011; Reboredo *et al.*, 2017) and the need for additional investigations under turbulent market conditions (Climent and Soriano, 2011). Indeed, the early findings of Silva and Cortez (2016) on the European and the US green market demonstrate better performance during crisis over non-crisis periods and the preference for green funds, compared to ESG funds, only for US funds, in contrast with the findings of Muñoz *et al.* (2014) who find performance in line with ESG funds for both the US and European funds during crisis periods.

Thus, the investigation into the hedging properties of ESG themes is a timely and relevant issue also considering some early findings that were primarily based on thematic investment funds, and the growing diffusion of thematic ESG indexes, such as governance and environmental indexes. However, given the preliminary stage of such studies, we formulate these alternative hypotheses:

H2a. ESG thematic indexes have different safe-haven properties, compared to Gold, WTI and BTC

H2b. ESG thematic indexes have different risk-hedging properties, compared to Gold, WTI and BTC

3. Sample characteristics and statistical properties

We build our database by collecting daily data from Thomson Reuters Data stream for the following ESG indexes: the MSCI China ESG leaders and the MSCI AC Asia Pacific ESG leaders. The Shanghai Stock Exchange Environmental protection index (SSE ENV), the Shanghai Stock Exchange sustainable development industry (SSE SUS) and the

Shanghai Stock Exchange Corporate Governance index (SSE CG) are used to test if ESG thematic indexes have different potentiality of safe-haven. As for the Chinese equity benchmark we use the Shanghai Stock Exchange (SSE) index and the Shenzhen Stock exchange (SZSE) index. Finally, we include traditional and innovative safe-haven assets to compare with ESG indexes. As a traditional safe-haven, we include the WTI (Corbet *et al.*, 2020) and the gold (Baur and Lucey, 2010). As an innovative safe-haven we use the BTC, which is "the best known, most widely traded cryptocurrency with the largest market capitalization" (Conlon *et al.*, 2020). We obtained all selected indexes denominated in US dollars to avoid concerns rising from the currency exchange risk within our analysis (see, e.g. Lyocsa *et al.* 2020). Table 1 summarizes the characteristics of the selected indexes. The sample period is from the January 1, 2017 to October 30, 2020. The starting point of our period is constrained by the availability of data on ESG indexes and by the necessity of excluding other turbulent periods before COVID-19 erupted, such as the oil shock in 2015–2016. Consistently, the selected period fits perfectly with the aim of investigating the WTI, GOLD, BTC and ESG safe-haven properties during relatively normal and crisis periods. Thus, we define the normal period from January 2017 to December 2019, while the eruption of the COVID-19 pandemic is from January 1, 2020 to the end of March 2020 (Corbet *et al.*, 2020). According to Albuquerque *et al.* (2020) and Ramelli and Wagner (2020), the first quarter of 2020 may be considered as the "fever" period, where financial markets suffered mostly the outbreak of the COVID-19 pandemic shock and first lockdown policies in Asia and Europe. Therefore, we consider the COVID-19 outbreak, as the first quarter of 2020, where hedging and safe-haven asset properties are more relevant for investors.

Index	Description
SSE	The SSE Composite Index is a stock market index of all stocks that are traded at the Shanghai Stock Exchange
SZSE	The SZSE Component Index is an index of 500 stocks that are traded at the Shenzhen Stock Exchange
MSCI China ESG leaders	The MSCI China ESG leaders Index is a capitalization weighted index that provides exposure to Chinese companies with high Environmental, Social and Governance (ESG) performance relative to their sector peers
MSCI AC Asia Pacific ESG leaders	The MSCI AC Asia Pacific ESG Leaders Index is a capitalization weighted index that provides exposure to Asiatic companies with high Environmental, Social and Governance (ESG) performance relative to their sector peers
SSE SUS	The SSE Sustainable development industry index is a capitalization weighted index including companies more engaged in educational, community and sustainable development-oriented practices in China
SSE ENV	SSE environmental protection industry index is a capitalization weighted index including Chinese stocks best in class in the resource management, clean technology products and pollution management practices
SSE CG	SSE 180 Corporate Governance Index includes companies more engaged in stakeholder-oriented governance and transparent accountability practices
BTC	The BTC index represents the market capitalization of the Bitcoin cryptocurrency
WTI	The WTI index represents the crude oil index
GOLD	The GOLD index is the market capitalization of the gold

Note(s): This table reports the names and the relative tickers for the SSE, SZSE, MSCI AC Asia Pacific ESG leaders, MSCI China ESG leaders, SSE SUS, SSE ENV, SSE CG, BTC, WTI and GOLD indexes provided by Thomson Reuters Datastream

Table 1. Selected sustainable and conventional indexes

Consistently, we computed the daily return of selected indexes as follow:

$$R_d = (LnP_d - LnP_{d-1})$$

Where R_d is the return for day d, and P_d is the price. Figure 1 plots the daily price return and value of all selected indexes. More precisely, looking at Figure 1 we notice a spike in a price change and value during the COVID-19 eruption, confirming the documented (see e.g. Corbet *et al.*, 2020; Onali, 2020) detrimental impact of it on financial markets. Table 2 provides a comprehensive descriptive statistic of all indexes analyzed.

Looking at the descriptive statistics (Table 2), we observe that the mean daily returns are positive for all selected indexes except for the WTI index. In line with previous research (e.g. Sabbaghi, 2020), we notice high values of the kurtosis of the returns, which indicates that the

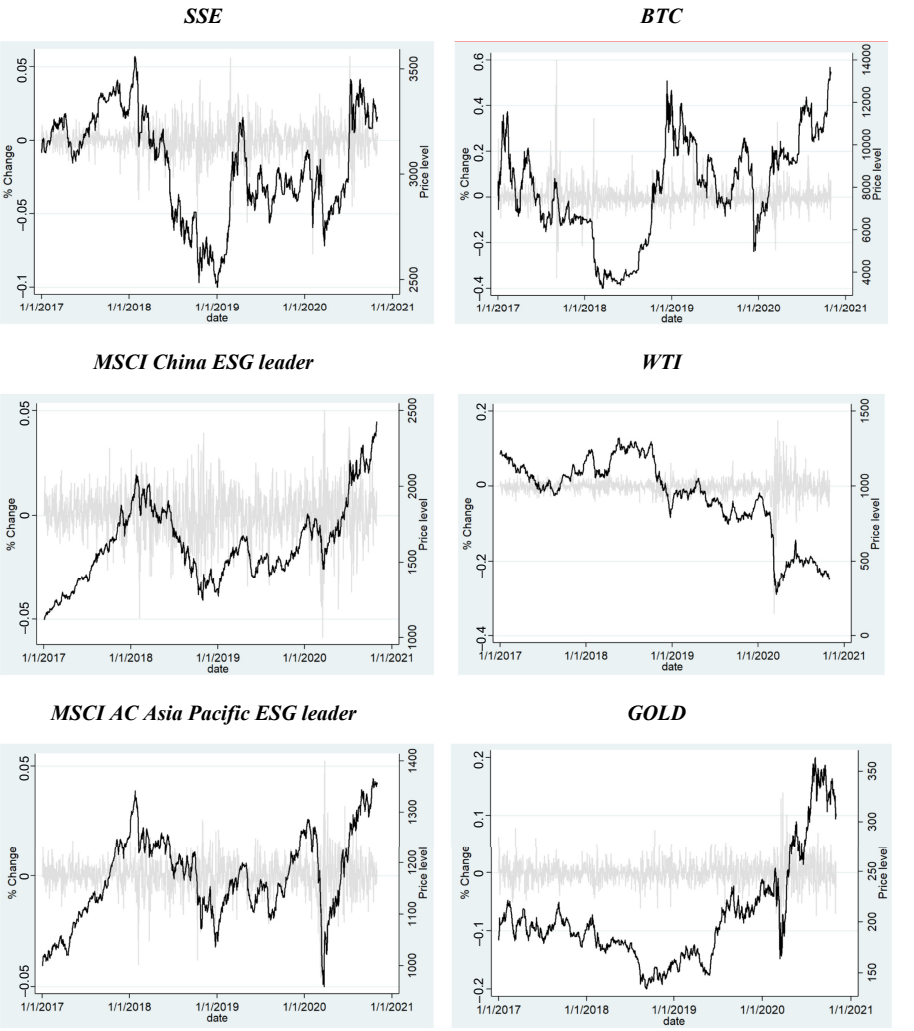

Figure 1.
Price and volatility of selected indexes

Index	Mean	Std. Dev	Min	Max	Skewness	Kurtosis	S–W test
SSE	0.0271	0.0135	−0.0849	0.0576	−0.613	9.876	0.9143***
SZSE	0.0204	0.0113	−0.0933	0.0671	−0.490	10.260	0.9000***
MSCI AC Asia Pacific ESG leaders	0.0373	0.0127	−0.0628	0.0576	−0.572	6.138	0.9810***
MSCI China ESG leaders	0.0308	0.0088	−0.0527	0.0523	−0.178	9.429	0.9285***
SSE SUS	0.0260	0.0159	−0.0810	0.0684	−0.221	8.049	0.9590***
SSE ENV	0.0158	0.0186	−0.0915	0.0827	−0.101	8.862	0.9431***
SSE CG	0.0177	0.0153	−0.0879	0.0677	−1.900	9.242	0.9337***
BTC	0.4017	0.0541	−0.3517	0.5992	−0.401	11.874	0.8083***
WTI	−0.0411	0.0211	−0.3404	0.1741	−0.191	12.209	0.7803***
GOLD	0.0160	0.0260	−0.1348	0.1392	−0.390	9.061	0.9383***

Note(s): This table presents descriptive statistics for the SSE, SZSE, MSCI AC Asia Pacific ESG leaders, MSCI China ESG leaders, SSE SUS, SSE ENV, SSE CG, BTC, WTI and GOLD. This table presents the annualized mean, annualized median, maximum of the daily returns, minimum of the daily returns, annualized standard deviation (SD), skewness, kurtosis and the Shapiro–Wilk test for the daily return series during the period 2017–2020. Significance codes: *** express significance at the 0.99 level, ** at 0.95, * at 0.90

Table 2.
Summary statistics

return of selected indexes presents some extreme values. This evidence seems to be confirmed also by the Shapiro–Wilk W test for normality (S–W test), which clearly shows the null hypothesis rejection of normality index returns distribution. We run the unconditional correlation of index returns to summarize the correlation between selected indexes (Table 3). As expected, all indexes are positively correlated (except for the Shanghai Stock Exchange Environmental protection index – SSE ENV, the Shanghai Stock Exchange Corporate Governance index – SSE CG, the WTI and the GOLD), indicating preliminary (unconditionally) high correlations between the Chinese equity market, ESG indexes and BTC indexes.

4. Econometric methodology

To test our hypotheses, we employ a multivariate GARCH model (MGARCH), where volatilities and correlations are a relation of past returns. The MGARCH models are widely adopted to study ESG indexes (e.g. Sadorsky, 2014), the effect of good and bad news on ESG index volatility (Sabbaghi, 2020) or to model the volatility and correlation among asset classes (Zghal and Ghorbel, 2020; Damiralay and Golitsis, 2021). In particular, we employ the DCC MGARCH model to explore the dynamic conditional correlation (DCC) among selected indexes. The DCC model guarantees the positive definiteness of the variance-covariance matrix of a return's distribution, by providing a stronger estimation for conditional correlations (Tse and Tsui, 2002). In addition, the DCC methodology offers the best performance among the families applicable to the large panel model (Engle and Sheppard, 2005).

Therefore, we apply a two-step estimation procedure to calculate the individual GARCH processes with time-varying volatility spill over and conditional correlation matrix. More precisely, first we estimate the conditional variance equations assuming Gaussian distribution to obtain the standardized innovations. In the second step, we obtain the parameters capturing the conditional correlation and other higher order moments for the whole sample.

The DCC GARCH model implies that the conditional variance-covariance matrix is decomposed as:

$$H_t = D_t R_t D_t \tag{1}$$

Table 3.
Unconditional correlation between indexes

	Index	1	2	3	4	5	6	7	8	9	10
1	SSE	1									
2	SZSE	0.8273	1								
3	MSCI AC Asia Pacific ESG leaders	0.6431	0.5577	1							
4	MSCI China ESG leaders	0.5443	0.4864	0.7874	1						
5	SSE SUS	0.0364	0.0317	0.0013	−0.0433	1					
6	SSE ENV	0.0226	0.0263	−0.0050	−0.0409	0.9147	1				
7	SSE CG	0.0046	0.0125	−0.0098	−0.0442	0.7860	0.7692	1			
8	BTC	0.0874	0.0647	0.0965	0.0933	0.0309	0.0434	0.0229	1		
9	WTI	0.1946	0.1521	0.3368	0.3540	−0.0605	−0.0330	−0.0339	0.1383	1	
10	GOLD	0.0579	0.0224	0.0894	0.0601	−0.0038	−0.0178	−0.0398	0.0903	0.1475	1

Note(s): This table reports the unconditional correlations among selected indexes for the total period of analysis (January 2017–October 2020)

where

$$D_t = diag\left(h_{1,t}^{1/2}, \ldots h_{n,t}^{1/2}\right) \tag{2}$$

and

$$R_t = diag\left(q_{1,t}^{-1/2}, \ldots q_{n,t}^{-1/2}\right) Q_t \;\; diag\left(q_{1,t}^{-1/2}, \ldots q_{n,t}^{-1/2}\right) \tag{3}$$

Equations for h are the univariate GARCH models (h is a diagonal matrix). Consistently, h_t can be expressed as

$$h_{i,t} = \omega + \sum_{0i}^{q\alpha} \varepsilon_{t-I}^2 + \sum_{0j}^{p\beta} h_{t-j} \tag{4}$$

Q, is the symmetric positive matrix

$$Q_t = (1 - \theta_1 - \theta_2)Q + \theta_1 z_{t\text{-}1} z'_{t\text{-}1} + \theta_1 Q_{t\text{-}1} \tag{5}$$

$\underline{Q}$ is the unconditional correlation matrix of the residuals. Parameters θ_1 and θ_2 are nonnegative and the correlation estimator is

$$\rho_{i,j,t} = q_{i,j,t} / \sqrt{\left(q_{(i,i,j)} q_{(j,j,t)}\right)} \tag{6}$$

As a robustness check, we redo our baseline analysis by employing both alternative benchmark indexes and alternative MGARCH models, such as the constant conditional correlation (CCC) model, the varying conditional correlation model (VCC) and the OLS regressions with Newey–West robust estimator (Baur *et al.*, 2018).

5. Results and discussion

Our baseline econometric methodology consists of running the multivariate DCC model (DCC) to investigate and plot volatility linkage between the Chinese equity market, ESG indexes, alternative safe-haven assets (BTC) as well as traditional ones (WTI and GOLD). Table 4 summarizes the parameters estimated for the DCC-GARCH. The ARCH parameter is represented by the α, while the GARCH parameter is represented by the β. Therefore, the α parameter measures the reaction of conditional volatility to market shock, while β reveals the persistency in conditional volatility. Looking at Table 4, the α parameters are significant at the 1% level and support remarkably lower volatility of ESG indexes than the Chinese equity market.

Index	ω	α	β
SSE	0.0004*	0.084***	0.902***
MSCI China ESG leaders	0.0012***	0.057***	0.896***
MSCI AC Asia Pacific ESG leaders	0.0008***	0.079***	0.887***
BTC	−0.0007	0.322***	0.631***
WTI	0.0001	0.120***	0.869***
GOLD	0.0002	0.058***	0.920***

Note(s): This table reports parameters estimates and log-likelihood values for the Dynamic Conditional Correlation (DCC) MGARCH model. Significance codes: *** express significance at the 0.99 level, ** at 0.95, * at 0.90

Table 4. DCC GARCH model

Consistently, considering its combination with the β, we rely on a higher persistence in the conditional volatility. Among the other assets, only GOLD performs qualitatively similar to the ESG indexes.

Table 5 presents correlations among the ESG indexes, SSE, BTC, oil (WTI) and GOLD indexes. The ARCH test provides statistically significant proof of heteroscedasticity and finally, it confirms that a GARCH (1,1) model perfectly fits the conditional variance distribution of the DCC series.

Consistent with other empirical studies (Paltrinieri *et al.*, 2018; Corbet *et al.*, 2020), we then predict the pairs of conditional variances among the selected Chinese benchmark and safe-haven assets. Figure 2 shows how the conditional variances of selected indexes changed over normal and the COVID-19 outbreak periods. Specifically, Panel A and Panel B of Figure 2 show the correlations between the Chinese equity market and ESG market (MSCI China ESG leaders and MSCI AC Asia Pacific ESG leaders index) during a normal period (left side) and the COVID-19 crisis (right side), clearly stressing lower volatility for the ESG index during both periods. Despite the fact that the lower volatility trend for ESG indexes seems to be more pronounced during the COVID-19 crisis, the greater resilience is confirmed also during the normal time, shedding new lights on the risk hedging properties of ESG assets.

Our results also show the stronger risk hedging properties of ESG indexes compared to BTC, WTI and GOLD, although results about the DCC among SSE, ESG, BTC, WTI and GOLD indexes do not allow us to validate the safe-haven properties of such indexes. In other words, both ESG indexes and assets generally considered as safe-havens (WTI, GOLD and BTC) are not "uncorrelated or negatively correlated" with SSE (Baur and Lucey, 2010). Table 5 clearly shows a positive correlation with the benchmark, thus indicating the systemic impact of COVID-19 on financial markets, at least in the first wave of virus-shock in China. Our findings expand the knowledge on safe-haven assets and the debate around BTC and ESG investments, confirming the superior resilience of ESG indexes in the risk-return trade-off, especially if compared to BTC.

Considering the great evolution of the ESG market and the establishment of several indexes separately focused on environmental or governance issues, we redo our DCC model, by testing which of the environmental and governance components offers the best risk hedging alternatives, compared to BTC, WTI and GOLD assets. Consistently, we used the following three Chinese environmental and governance indexes: the SSESUS, the SSEENV index and the SSECG index [1].

Table 6 shows that the SSE ENV index offers the best risk hedging properties among the other ESG indexes. Relevant risk-hedging properties are also offered by the SSE SUS and the

Index	Corr
SSE-MSCI China ESG leaders	0.6180***
SSE-MSCI AC Asia Pacific ESG leaders	0.5340***
SSE-BTC	0.0701
SSE-WTI	0.1511***
SSE-GOLD	0.0111
Adj	
Lambda 1	0.0081***
Lambda 2	0.9711***

Note(s): This table reports the dynamic conditional correlation (DCC) between the SSE and MSCI AC Asia Pacific ESG leaders, MSCI China ESG leaders, BTC, WTI and GOLD used in our analysis during the whole period considered (January 2017–October 2020). Index definitions are provided in Table 1. Significance codes: *** express significance at the 0.99 level, ** at 0.95, * at 0.90

Table 5.
DCC results

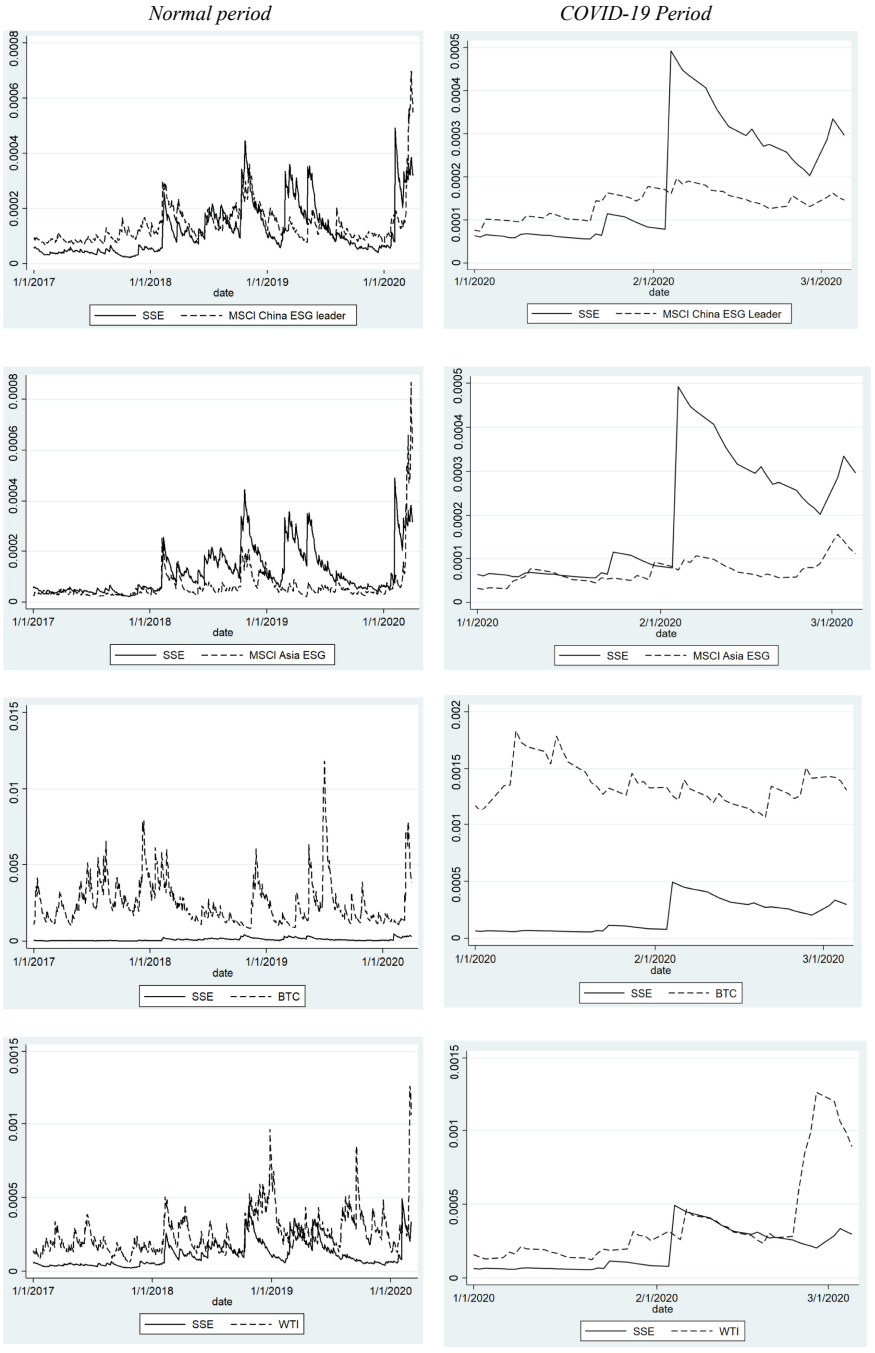

Figure 2.
SSE vs. safe-haven selected indexes before and during COVID-19

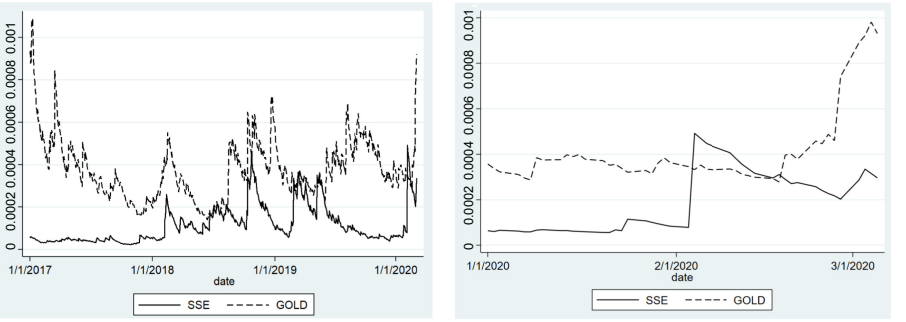

Figure 2.

Note(s): This figure provides a comparison of volatility trend for the indexes used in our analysis between normal period times (January 2017- December 2019) (left) and the COVID-19 pandemic period (right) (January 2020-March 2020). Index definitions are provided in Table 1

Index	ω	α	β
SSE	0.0002	0.091***	0.909***
SSE SUS	0.0004	0.085***	0.863***
SSE ENV	0.0002	0.084***	0.843***
SSE CG	0.0005*	0.101***	0.843***
BTC	−0.0008	0.330***	0.629***
WTI	−0.0005	0.131***	0.861***
GOLD	0.0001	0.060***	0.928***

Table 6.
DCC GARCH model for ESG index components

Note(s): This table reports parameters estimates and log-likelihood values for the Dynamic Conditional Correlation (DCC) MGARCH for the SSE and SSE SUS, SSE ENV, SSE CG, BTC, WTI and GOLD. Significance codes: *** express significance at the 0.99 level, ** at 0.95, * at 0.90

SSE CG. When compared with the Chinese equity market (SSE), the most resilient assets seem to be the SSE ENV, the SSE SUS and GOLD. As for the BTC and the WTI, we do not find any risk hedging opportunities compared to the SSE. Table 7 shows that no safe-haven properties are shown by the selected environmental and governance indexes.

Taken together, the results on the greater resilience of the ESG index support the moral capital theory assumption (Bouslah *et al.*, 2018), confirming its validity also during a

Index	Corr
SSE-SSE SUS	0.0486
SSE-SSE ENV	0.0400
SSE-SSE CG	0.0391
SSE-BTC	0.0690
SSE-WTI	0.1460***
SSE-GOLD	0.0223
Adj	
Lambda 1	0.0138***
Lambda 2	0.960***

Table 7.
DCC results

Note(s): This table reports the Dynamic Conditional Correlation (DCC) between the SSE and SSE SUS, SSE ENV, SSE CG, BTC, WTI and GOLD used in our analysis during the whole period considered (January 2017–October 2020). Index definitions are provided in Table 1. Significance codes: *** express significance at the 0.99 level, ** at 0.95, * at 0.90

disruptive economic and financial shock such as that caused by the COVID-19 pandemic. Similarly, the lower volatility of the SSE ENV and SSE SUS indexes emphasizes the importance of environmentally and socially responsible investments as a portfolio hedging strategy during the COVID-19 crisis. The eruption of the pandemic leads to an unprecedented demand and supply shock finally affecting the economic value chain worldwide and the oil prices (Baldwin and Weder, 2020). Subsequently, the oil-shock price more deeply affected emerging economies, amplifying the disruptive effect of the COVID-19 pandemic on financial markets (Baldwin and Weder, 2020). The lower volatility of environmental indexes, indeed, may be advantaged by the substitute effect documented with oil and thus they may be employed as risk-hedging when pressures occur on the oil markets, although environmental indexes do not explicitly target green energies, but wider environmental aims. Therefore, we rely on the lower exposition of the environmental investments to the pandemic risk and its wasting consequences on the oil chain.

Similarly, indexes targeting social issues are shown to be a relevant risk hedger against the social challenges posed by the COVID-19 pandemic (e.g. He and Harris, 2020; Van Lancker and Parolin, 2020). Thus, the diffusion of this type of index and related financial products appears suitable also from a financial perspective.

6. Robustness checks

To strengthen the validity of our results, in this section we perform the following four robustness tests: (1) firstly, we rerun our baseline model by employing the SZSE as an alternative Chinese equity benchmark; (2) secondly, we run the CCC MGARCH and the VCC MGARCH as alternative econometric models; (3) we run the OLS Newey–West estimator (Mariana *et al.*, 2021; Baur *et al.*, 2018) to further check if any selected indexes exhibit safe-haven properties during the COVID-19 outbreak; (4) Finally, we show the optimal weight and hedging ratio as in Akhtaruzzaman *et al.* (2020).

Consistently, we test our first hypothesis on the SZSE. Therefore, after obtaining the daily price return of the SZSE from January 2017 to the end of December 2019, we compare the safe-haven properties of ESG indexes (MSCI China ESG leaders and MSCI Asia ESG), the BTC, the WTI and the GOLD.

Table 8 presents a lower α parameter for the MSCI China ESG leaders' index compared to the SZSE. Only GOLD presents α in line with the MSCI China ESG leaders index, while the MSCI AC Asia Pacific ESG leaders, the WTI and the BTC present higher values of α.

These additional results are in line with our previous findings on SSE and corroborate the recent empirical findings about the risk hedging properties of ESG investments (e.g. Cheung, 2016).

Index	ω	α	β
SZSE	0.0004	0.074***	0.887***
MSCI China ESG leaders	0.0012***	0.059***	0.882***
MSCI AC Asia Pacific ESG leaders	0.0008***	0.078***	0.879***
BTC	−0.0005	0.331***	0.624***
WTI	0.0002	0.124***	0.864***
GOLD	0.0002	0.061***	0.925***

Note(s): This table reports parameters estimates and log-likelihood values for the Dynamic Conditional Correlation (DCC) MGARCH for the SZSE and MSCI AC Asia Pacific ESG leaders, MSCI China ESG leaders, BTC, WTI and GOLD used in our analysis during the whole period considered (January 2017–October 2020). Index definitions are provided in Table 1. Significance codes: *** express significance at the 0.99 level, ** at 0.95, * at 0.90

Table 8. Alternative Chinese benchmark

Additionally, we check the consistency of our inference by running both the CCC MGARCH and the VCC MGARCH as proof of robustness. More precisely, the CCC MGARCH considers the decomposition of the conditional covariances of past returns into their conditional correlations and conditional standard deviations components. Unlike the DCC MGARCH, the CCC MGARCH assumes that the conditional correlation matrix is constant over time, while the univariate conditional standard deviations vary over time (McAleer *et al.*, 2008). Conversely, the VCC MGARCH models the covariances as a (nonlinear) function of the conditional correlation, assuming that the conditional correlation matrix is varying over time, allowing more flexibility than the CCC and the DCC models. Specifically, the conditional correlation parameters follow the GARCH-like process specified in Tse and Tsui (2002). Therefore, running these two additional models allows us to strengthen the validity of our results, addressing potential issues arising with a constant and VCC matrix.

Table 9 and 10 show the results of both the CCC and the VCC MGARCH models. The robustness tests confirm that MSCI China ESG leaders is the index with the lowest α parameters for both CCC and VCC models. Thus, these findings validate the risk hedging properties of sustainable investments.

Additionally, in the spirit of previous research (see, e.g. Mariana *et al.*, 2021; Baur *et al.*, 2018) we test the consistency of no safe-haven asset properties of selected indexes by running an alternative econometric model such as the OLS specified as follow:

$$SSE(SZSE)t = \alpha + \beta_0 ChinaESGt_{-1}{*}Covid + \beta_1 AsiaESGt_{-1}{*}Covid + \beta_2 BTCt_{-1}{*}Covid + \beta_3 WTIt_{-1}{*}Covid + \beta_4 WTIt_{-1}{*}Covid + \beta_5 GOLDt_{-1}{*}Covid + \boldsymbol{\beta}_6 \boldsymbol{X}_{-1} + \varepsilon t.$$

where $\beta_{(0,1,2,3,4,5)}$ represents coefficients of interests and thus captures the safe-haven properties of selected ESG, BTC, WTI and GOLD indexes during the COVID-19 lagged of one period with respect to the SSE and SZSE return, respectively. $\boldsymbol{\beta}_6 \boldsymbol{X}_{-1}$ represents the vector of selected ESG, BTC, WTI and GOLD indexes during the total period. Finally, *Covid* is a dummy variable equal to 1 for January 2020–March 2020 time period and 0 otherwise. According to Baur *et al.* (2018), if selected assets are potential safe-haven, the interaction with *Covid* dummy variable should be positive and statistically significant correlated to the benchmark return. In other words, during the pandemic, a safe-haven return should be positively associated with the benchmark return and negative negatively correlated during normal times. Looking at Table 11, no one of the indexes are statistically correlated with SSE and SZSE return during COVID-19 period, therefore neither can be purely considered a safe-haven asset for the Chinese stock market indexes. Again, the OLS results strengthen the validity of our inference, by confirming DCC-CCC-VCC results.

	VCC			CCC		
Index	ω	α	β	ω	α	β
SSE	0.0004	0.083***	0.904***	0.0004	0.080***	0.902***
MSCI China ESG leaders	0.0013***	0.054***	0.903***	0.0014***	0.055***	0.888***
MSCI AC Asia Pacific ESG leaders	0.0007***	0.075***	0.891***	0.0008***	0.079***	0.880***
BTC	−0.0006	0.323***	0.630***	−0.0006	0.326***	0.628***
WTI	0.0001	0.122***	0.869***	0.0001	0.125***	0.866***
GOLD	0.0003	0.058***	0.929***	0.0003	0.060***	0.926***

Table 9. VCC and CCC MGARCH models

Note(s): This table reports parameters estimates and log-likelihood values for the Varying Conditional Correlation (VCC) and Constant Conditional Correlation (CCC) MGARCH models. Significance codes: *** express significance at the 0.99 level, ** at 0.95, * at 0.90

Index	VCC Corr	CCC Corr
SSE-MSCI China ESG leaders	0.624***	0.622***
SSE-MSCI AC Asia Pacific ESG leaders	0.533***	0.521***
SSE-BTC	0.0942**	0.0960***
SSE-WTI	0.150***	0.152***
SSE-GOLD	0.0369	0.0413
Adj		
Lambda 1	0.008***	0.008***
Lambda 2	0.969***	0.970***

Note(s): This table reports the Varying Conditional Correlation (VCC) and Constant Conditional Correlation (CCC) between the SSE and MSCI AC Asia Pacific ESG leaders, MSCI China ESG leaders, BTC, WTI and GOLD used in our analysis during the whole period considered (January 2017–October 2020). Index definitions are provided in Table 1. Significance codes: ***express significance at the 0.99 level, ** at 0.95, * at 0.90

Table 10.
VCC and CCC results

Index	SSE	SZSE
ChinaESG (−1) *Covid	−0.0560 (0.177)	0.0469 (0.171)
AsiaESG (−1) *Covid	−0.133 (0.160)	−0.176 (0.149)
BTC (−1) * Covid	0.0128 (0.0206)	−0.00467 (0.0193)
WTI (−1) * Covid	−0.0302 (0.0687)	0.00373 (0.0579)
GOLD (−1) * Covid	0.0548 (0.0529)	0.0535 (0.0471)
AsiaESG (−1)	−0.0322 (0.0756)	−0.0410 (0.0571)
ChinaESG (−1)	0.0846* (0.0451)	0.0804** (0.0387)
BTC (−1)	0.00319 (0.00569)	0.00455 (0.00438)
WTI (−1)	0.0562** (0.0240)	0.0488*** (0.0168)
GOLD (−1)	0.00562 (0.0156)	0.00297 (0.0125)
Covid	−0.00135 (0.00216)	−0.00199 (0.00219)
Observations	1,259	1,259
R-squared	0.028	0.040

Note(s): This table reports the estimates of OLS model with Newey–West standard errors during the total period (Jan. 2017–Oct. 2020). The dependent variables are SSE and SZSE which represent Chinese stock market benchmark. The target variables are the ChinaESG*Covid, AsiaESG*Covid BTC*Covid, WTI*Covid and GOLD*Covid which capture safe-haven asset properties of selected indexes. Index definitions are provided in Table 1. The superscripts ***, ** and * denote coefficients statistically different from zero at the 1%. 5% and 10% levels, respectively, in two-tailed tests

Table 11.
OLS with Newey–West standard errors result

Finally, we calculate the optimal weight and the optimal hedge ratio to minimize the financial risk using ESG indexes, BTC, WTI and GOLD to reduce exposure to SSE in China. More precisely, following Akhtaruzzaman *et al.* (2020), in Table 12 we calculate the optimal weight ratio, showing that MSCI Asia ESG index, MSCI China ESG and GOLD show the lower optimal weight and hedge ratio, confirming that ESG indexes are the most effective indexes to hedge SSE position, strengthening our baseline assumptions.

	MSCI ESG	MSCI ESG Asia	BTC	WTI	GOLD
Optimal weight	0.401	0.301	0.601	0.482	0.101
Optimal hedge ratio	0.202	0.091	0.531	0.231	0.141

Note(s): This table reports the estimates of the optimal hedge weight and hedge ratio between SSE and selected assets

Table 12.
Optimal weight and hedge ratio

7. Conclusion

The study represents one of the first empirical contributions examining the safe-haven and hedging properties of ESG indexes compared to traditional and innovative safe-haven assets.

The findings provide empirical evidence of the risk hedging properties of the ESG indexes as well as the environmental, social and corporate governance thematic indexes during the outbreak of the COVID-19 crisis. The results also support the superior risk hedging properties of ESG indexes over BTC, and in line with relevant literature, the risk-hedging properties of gold.

These results have several practical and theoretical implications. First, the results suggest that in terms of trading, asset managers and institutional investors can leverage the documented risk-hedging properties of ESG assets by overweighting ESG indexes and/or underweighting conventional ones both in short and long-time horizons. Second, our results stress the systemic nature of the COVID-19 related shock. Specifically, we find that none of the traditional hedging assets offered a real safe-haven property for investors, showing at least a correlation with the benchmark. Taken together, these results offer fresh insight that can be also considered valid when exogenous financial/economic shocks occur, such as that documented by COVID-19.

Third, we shed light on the often-abused concept of safe-haven asset and risk hedging, trying to address these differences related to the growing attention on ESG and BTC investments. We, therefore, combine two streams of research with open debates, sustainable finance and cryptocurrency, addressing which of these two megatrends allows investors to better strategically hedge the exposure to indirect financial shock, such as that caused by the COVID-19 pandemic.

Our paper is subject to limitations and suggests future research development in the ESG and crypto-related literature. Although we provide strong evidence on the ESG investments risk-hedging properties, we focus on Chinese financial markets, which are recognized as the epicenter of the COVID-19 pandemic, one of the growing ESG markets, although relatively investigated by ESG studies. Thus, future research may expand the research questions to other geographical areas and/or may differentiate between the first, second and third waves of the COVID-19 outbreak. In this context, expanding the period of analysis may be of interest for future researcher aimed at exploring the consistency of our results distinguishing between the "fever" phase of COVID-19 and other phases where additional forces (i.e. policy interventions, monetary policy announcements and vaccine discovery) may have affected financial markets, and ESG, BTC, WTI and GOLD hedging or haven asset properties.

Note

1. The rationale behind the selection of these three specifics environmental, social and governance indexes is that these are the only three ESG thematic indexes available in China.

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