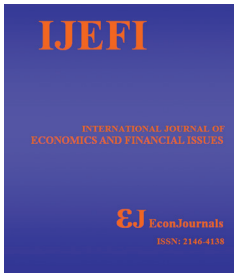

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Cryptocurrencies Versus Gold: Safe-haven Competition

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ABSTRACT

This study investigated the impact of the COVID-19 pandemic on two cryptocurrencies, Bitcoin and Ethereum, on the one hand, and gold, on the other hand. We analysed a large dataset from 13 countries worldwide. This study aimed to identify a reliable safe haven for investors during a health crisis. Our results indicated a positive association between Bitcoin and Ethereum prices and the COVID-19 variables. However, the relationship between gold prices and COVID-19 health indicators differed among countries, with inconsistent results.

Keywords: Cryptocurrencies, Bitcoin, Ethereum, Gold, COVID-19
JEL Classifications: G15, Q02

1. INTRODUCTION

The COVID-19 pandemic has shaken up certain financial and economic concepts. The emergence of cryptocurrencies over the past decade and the coronavirus disease (COVID-19) health crisis have led to the emergence of new concepts in the financial world. For a long time, gold was the most important safe haven for investors during times of war and economic and health crises. However, the COVID-19 crisis has revealed other potential safe havens, such as cryptocurrencies. Indeed, several authors have posited that Bitcoin is a safe haven, like gold during times of crisis, while others believe that Tether is the best safe haven during times of crisis. Goodell and Goutte (2021) empirically validated that Tether offers an alternative to the US dollar during times of crisis.

In this study, we aim to analyse the relationship between the COVID-19 crisis and the stock market price of gold, on the one hand, and of some cryptocurrencies, on the other hand. We want to see whether there is a statistically significant relationship between some variables that define the COVID-19 crisis and the price of gold and of the main cryptocurrencies that we define later. Our hypothesis is that the deterioration and exacerbation of the health situation following the pandemic, and consequently the explosion in the numbers of infected people and deaths, positively impact the price of gold and cryptocurrencies. In other words, we believe that cryptocurrencies can be a safe haven for investors during times of crisis and that gold may no longer be the most important safe haven during such times. We empirically validate this hypothesis throughout this study.

2. LITERATURE REVIEW

During 2020-2021, research on cryptocurrencies expanded, particularly since the COVID-19 pandemic. Most empirical studies confirm that Bitcoin is a safe haven asset (Abidi and Touhami, 2024). For example, Zijian and Qiaoyu (2021) show that short-term trading in Bitcoin can generate large profits and that portfolios can be optimised by investing in Bitcoin. As blockchain technology advances and the number of cryptocurrencies increases, investors are increasingly diversifying their portfolios with cryptocurrencies (Jiang et al., 2021). Huynh et al. (2020) find that investors are investing in cryptocurrencies and green energy following the

fourth industrial revolution, providing further evidence of the link between cryptocurrencies and green energy. Additionally, recent research has shown that investors are diversifying their portfolios between commodities and cryptocurrencies (Al-Yahyaee et al., 2019; Anandhabalaji et al., 2023; Dias et al., 2024; Kushwah et al., 2024). Notably, the cryptocurrency market is dominated by Bitcoin. Most research on cryptocurrencies focuses on Bitcoin, with only a few studies examining the relationship between other cryptocurrencies, such as Ethereum and Litecoin, and their effects on financial markets (Conlon et al., 2020; Umar et al., 2021c).

The COVID-19 pandemic has highlighted the high degree of interdependence between the cryptocurrency and commodity markets. Jareño et al. (2021) find a high degree of interdependence between oil prices and cryptocurrency prices during economic turbulence, such as the COVID-19 pandemic. Yin et al. (2021) show that oil price shocks lead to significant uncertainty in the cryptocurrency market. Jareño et al. (2021) postulate a significant positive (negative) relationship between oil shocks and the cryptocurrency market, depending on the direction of the shock. They also find a strong interconnection between the performance of cryptocurrencies and oil shocks during crises.

Klein et al. (2018) refer to Bitcoin as the new gold. Guesmi et al. (2019) indicate that portfolio diversification strategies, including gold, oil, equities, and Bitcoin, have a lower level of risk than traditional diversification strategies that focus only on equities and commodities. Thus, understanding how cryptocurrencies react in times of crisis is important (Jareño et al., 2021). Gonzalez et al. (2020) have studied the behaviour of three asset portfolios consisting of stocks, bonds, and cryptocurrencies or gold for the pre- and post-COVID-19 periods and have found a significant inverse relationship in some cryptocurrencies, bonds, and stocks.

Bouri et al. (2017) show that Bitcoin is a very effective diversification tool in times of economic crises. Goodell (2020) analysed the effect of the COVID-19 crisis on the industrial sector and find a positive relationship. Yarovaya et al. (2021) examine the effect of the COVID-19 pandemic on herd behaviour. Other studies have examined the positive relationship between commodity prices, stock prices, and economic policy uncertainty (Aloui et al., 2020; Sharif et al., 2020). Goodell and Goutte (2021) use several econometric methods, such as wavelet coherence analysis (from Kang et al., 2019) and neural network analysis, to analyse the role of the COVID-19 pandemic on the co-movements of four cryptocurrencies with seven stock indices. Goodell and Goutte (2021) argue that the COVID-19 pandemic significantly impacted the relationship between cryptocurrencies and financial markets. They postulate that Tether (pegged to the dollar) was more stable than Bitcoin during the pandemic.

Goodell (2020) assumes that the COVID-19 pandemic negatively impacted financial markets. However, it is reasonable to assume that it did not have the same effect on different types of cryptocurrencies. Kurka (2019), Matkovskyy and Jalan (2019), and Wang et al. (2019) have studied how cryptocurrencies behave under high uncertainty. Karamti and Bellhassine (2022) find a significant positive relationship between American citizens fear following the COVID-19 pandemic and Bitcoin during the first wave of the pandemic. However, the fear index invaded the Bitcoin market during the second wave of the COVID-19 pandemic, calling into question the assumption that Bitcoin is a safe haven for investors. Within the same analytical framework, the literature shows a correlation between several cryptocurrencies and that this correlation increases as the COVID-19 crisis intensifies. Goodell and Goutte (2021) find a co-movement between cryptocurrency prices and equity indices. This dependence increased as the COVID-19 pandemic intensified. They also find that the positive relationship between cryptocurrency prices and equity indices intensified as the COVID-19 pandemic progressed.

Corbet et al. (2018), and Feng et al. (2018) find nuanced evidence of a correlation of cryptocurrencies with other financial assets. Canh et al. (2019) show that cryptocurrencies have a significant relationship with economic factors. However, Kurka (2019) finds a weak correlation between Bitcoin and assets other than gold. The same result is obtained by Jareño et al. (2021), who identify a significant relationship between Bitcoin and gold. Therefore, Bitcoin can be considered a safe haven during periods of economic turmoil.

Mokni et al. (2020) show that during a Bitcoin crash, the US stock market remained stable, confirming the existence of a negative relationship between Bitcoin and S and P 500 index. This confirms the hypothesis that Bitcoin is a safe haven for investors. In contrast, Smales (2019) confirms that there is no significant relationship between the performance of Bitcoin and other financial assets and that Bitcoin does not represent a safe haven. Indeed, the relationship between cryptocurrencies and stock markets becomes more unstable during crises, as shown by López-Cabarcos et al. (2021). The classic safe haven view holds that gold is the safest investment during crises. However, the fourth industrial revolution has seen Bitcoin emerging as a direct competitor to gold. Recent research suggests that a new cryptocurrency, Tether, is even safer than Bitcoin.

Goodell and Goutte (2021) find that Tether was negatively correlated with stock prices during the COVID-19 crisis because it was pegged to the US dollar. The VIX index, a measure of market volatility, also moves negatively with Bitcoin, Ethereum, and Litecoin, but positively with Tether. This suggests that Tether offers an alternative to the dollar as a safe haven asset during crises. Da Gama Silva et al. (2019) and Wei (2018) find that when Bitcoin's price falls, the volume of Tether traded increases. Hale et al. (2018) find that Tether investors are more experienced and informed than investors in other cryptocurrencies. Goodell and Goutte (2021) also identify an inverse relationship between stock market indices and the Tether price, which intensified as the number of COVID-19 cases increased. This supports the hypothesis that Tether is a true safe haven asset during crises. Jareño et al. (2021) argue that Tether deserves special attention because it is the cryptocurrency least correlated with oil prices. These findings are significant for both investors and policymakers.

The empirical results show that Tether is a good portfolio diversifier. While cryptocurrencies can provide a safety blanket for investors, commodities can also be effective diversification assets.

Rehman and Vo (2020) find that copper is a particularly important diversification asset for cryptocurrencies in the short term. Li and Meng (2022) find that cryptocurrencies can be used to optimise portfolios, with the optimal weights of cryptocurrencies still high at investment horizons. In conclusion, recent empirical work has shown that cryptocurrencies, such as Bitcoin and Tether, can be effective diversification and risk-hedging assets, and can also serve as true safe haven assets for investors during times of crisis.

3. METHODOLOGY AND EMPIRICAL STUDY

3.1. Sample

To investigate the impact of the COVID-19 pandemic on cryptocurrencies and gold, we created a sample of 13 countries, including four dependent and four independent variables. The number of daily observations varied from 5408 to 7864 for the period January 01, 2020-August 31, 2021. Data on COVID-19 cases (number of new cases, cumulative cases, deaths, cumulative deaths, and recoveries) were collected from the open stats coronavirus website of the efficient agency, which gathers statistics from the ministries of health in each country. Data on cryptocurrencies and gold were collected from the Yahoo finance website.

To analyse the impact of the COVID-19 pandemic on cryptocurrencies and gold returns, we used a generalised least squares regression with correlated disturbances (GLS) on daily observations for nine countries around the world. We chose this model because it accounts for both autocorrelation and heteroscedasticity problems. Our study covered the period from January 2020 to August 2021 (609 days). First, we conducted a descriptive statistical analysis to identify the statistical characteristics of the data. We then performed preliminary tests, such as the Wooldridge test for autocorrelation and the Cook-Weisberg test for heteroscedasticity.

3.2. Variables

Our study was structured around four dependent and four independent variables. The dependent variables described the main cryptocurrencies on the market: Total cumulative cases (TCC), new cases (NC), total deaths (TD), and total recoveries (TH). The independent variables described the lagged prices of order (1) of cryptocurrencies such as Bitcoin (BTC), Ethereum (ETH), Tether (USDT), and gold (GLD). We initially attempted to study the price returns of gold and the different cryptocurrencies, but this led to poor results. To address this problem, we calculated the first difference in different prices to study their performance.

3.3. Descriptive Statistics

To gain a basic understanding of the data, we conducted descriptive statistics as shown in Table 1.

The first group of variables was independent and the second group was dependent. The descriptive statistics showed that the cumulative number of new COVID-19 cases (TCC) in the nine sampled countries between March 2020 and August 2021 was very high (39,057,368 cases) compared to that in other countries worldwide. This provides a preliminary idea of the pandemic's impact on financial markets. The average number of new cases per day was 25,698 with a standard deviation of 85,309. The variable TD represents the total number of deaths, which peaked at 200,559 during the same period. The average number of total deaths (TD) during this period was 558. The total number of recoveries (TH) averaged 21,406, which is higher than the number of deaths. Information on the number of recoveries can affect financial markets, and subsequently, cryptocurrency performance. The second group of variables, concerning cryptocurrencies and gold prices, was highly volatile between March 2020 and August 2021. This was due to the waves of panic experienced by investors and speculators. For example, the standard deviation of Bitcoin was 17,874, which is very high compared to the average, given its statistical moments, against a minimum of 4,970 dollars and a maximum of 63,503 USD. Indeed, the COVID-19 pandemic period was characterised by several waves following the appearance of several variants of the SARS-CoV-2 virus. This led to price rebounds in several cryptocurrencies. Ethereum averaged 1,168 with a standard deviation of 1,050 and a minimum of 110, against a maximum of 4,168. The statistical findings were valid for the variable ETH, with a high standard deviation compared to the average, indicating high volatility in Ethereum due to the succession of COVID-19 waves. However, the Tether cryptocurrency (USDT) did not react much to the COVID-19 crisis. The variable USDT recorded a mean of 1.001 and a standard deviation of 0.003, making it the most stable cryptocurrency during the pandemic. This may be due to its strong dependence on the US dollar. Finally, the gold price was relatively stable, with a low volatility of 97.41. It reached a maximum of 2051 dollars. It remains to be seen in the following sections which assets are the real safe havens.

Table 1: Descriptive statistics

Variable	Obs.	Mean	Standard Deviation	Min	Max
TCC	4848	5024629	8421792	2	3.91e+07
NC	4724	25697.85	85308.95	1	4822466
TD	4886	558.0659	4636.024	0	200559
TH	4127	21406.47	227557.2	0	1.32e+07
BTC	4905	26204.13	17874.33	4970.79	63503.46
ETH	4903	1168.492	1050.359	110.61	4168.7
TEH	4904	1.001022	0.0035775	0.9742	1.0536
GLD	3394	1805.912	97.41302	1477.3	2051.5

TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries, BTC: Bitcoin, ETH: Ethereum, GLD: Gold

Table 2 shows the correlation coefficients between the sets of dependent and independent variables. The results confirm the absence of a strong correlation, and hence a correlation problem, between the variables in our study. The variance inflation factor test confirmed these results (Table 3).

3.4. Econometric model

To study the impact of the COVID-19 crisis on the cryptocurrency market and the variability in the gold price, we analysed three cryptocurrencies: Bitcoin, Ethereum, and Tether. We analysed the impact of the COVID-19 pandemic (in terms of TCC, NC,

Table 2: Pairwise correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) TCC	1							
(2) NC	0.293	1						
(3) TD	0.095	0.080	1					
(4) TH	0.145	0.093	0.030	1				
(5) BTC	0.422	0.103	0.048	0.051	1			
(6) ETH	0.472	0.095	0.030	0.050	0.877	1		
(7) TEH	−0.067	−0.018	−0.002	0.047	−0.112	−0.112	1	
(8) GLD	0.052	0.073	0.014	0.089	−0.033	0.037	0.064	1

TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries, BTC: Bitcoin, ETH: Ethereum, GLD: Gold

Table 3: Variance inflation factor

Variable	VIF	1/VIF
TCC	1.127	0.887
NC	1.103	0.907
TH	1.024	0.976
TD	1.016	0.985
Mean VIF	1.067	

TCC: Total cumulative cases, NC: New cases, TD: Total deaths

TD, and TH) on these cryptocurrencies and the gold price using panel data estimations. However, to avoid econometric problems related to the autocorrelation of residuals and heteroscedasticity, we used a cross-sectional time-series (FGLS) model (Table 4).

$$\alpha_{i,t} = \beta_0 + \beta_1(TCC_{i,t}) + \beta_2(NC_{i,t}) + \beta_3(TD_{i,t}) + \beta_4(TH_{i,t}) + \varepsilon_{i,t} \quad (1)$$

$\alpha_{i,t}$ represents the set of dependent variables (GLD, BTC, ETH, and TEH).

3.5. Preliminary econometric test

To identify the econometric characteristics of the models, we first conducted preliminary econometric tests, such as the Wooldridge test (2002) for serial autocorrelation and the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity.

The results of the autocorrelation test for most models showed a Fisher probability below the critical threshold of 5%, which led us to accept the null hypothesis of autocorrelation. Similarly, most heteroscedasticity test results showed a chi-squared probability below the critical threshold of 5%, also leading us to accept the null hypothesis and confirm the presence of heteroscedasticity.

To address the statistical problems identified in the preliminary tests, we estimated the panel data models using the FGLS model to avoid autocorrelation and heteroscedasticity problems.

4. RESULTS

This empirical study investigates the impact of the COVID-19 pandemic on the cryptocurrency and commodity markets, particularly gold. Specifically, we use panel data regression to study the impact of the health crisis on Bitcoin, Ethereum, Tether, and gold. We conduct an impact study on nine countries from different continents to determine whether there are behavioural differences among investors.

4.1. The Effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of the US)

We begin by studying the impact of the COVID-19 pandemic on various cryptocurrencies and gold in the US. Table 5 shows the results for the US.

The results in Table 5 show the impact of the different COVID-19 pandemic variables on gold and cryptocurrencies defined above. In the first estimation (dependent variable "Gold"), only two variables, TCC and NC, are statistically significant at the 1% level. The first has a positive effect, whereas the second has a negative effect. Thus, an increase in the number of cumulative cases in the US had a positive impact on gold prices. For Bitcoin, all variables describing the health crisis are positive and statistically significant except for TD. The same is true for the third estimate (ETH), except that the variable (NC) has a negative effect on the price of Ethereum. Finally, the fourth regression shows that only TD positively affects the price of Tether. Thus, Tether investors are not sensitive to TCC or NC and seem to be more reasonable and rational than investors in other cryptocurrencies.

4.2. The effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of Brazil)

Table 6 presents the estimates of the impact of the COVID-19 pandemic on gold and various cryptocurrencies in Brazil.

The results for the first estimate on the gold price show that TCC and TD are negative and statistically significant at the 5% level. In other words, the gold price improved as the intensity of the COVID-19 pandemic weakened, which is inconsistent with the hypothesis that gold is a safe haven for investors. However, TCC has a positive effect on Bitcoin and Ethereum, but a negative effect on Tether. An increase in TCC contributes to the increase in the prices of Bitcoin and Ethereum. This result supports the hypothesis that cryptocurrencies are safe havens for some investors.

4.3. The effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of Argentina)

In this subsection, we study the impact of the COVID-19 pandemic on the gold price and the cryptocurrencies defined above. Table 7 shows the results of the various estimates.

The first estimate, concerning the effect of the health crisis on gold, shows a negative and statistically significant coefficient for TCC at the 1% level. This inverse relationship between TCC and the price of gold does not align with the economic theory that gold is a safe haven for investors in times of crisis.

Table 4: Autocorrelation and heteroscedasticity test

Country	Variable	Test	Specification	Statistic	Probability
USA	GLD	Autocorrelation	Fisher	1194	0.000
		Heteroscedasticity	Chi-square	1.31	0.252
	BTC	Autocorrelation	Fisher	3449	0.000
		Heteroscedasticity	Chi-square	2.30	0.129
	ETH	Autocorrelation	Fisher	935	0.000
		Heteroscedasticity	Chi-square	16.23	0.000
	TEH	Autocorrelation	Fisher	24.898	0.000
		Heteroscedasticity	Chi-square	40.82	0.000
Brazil	GLD	Autocorrelation	Fisher	1194	0.000
		Heteroscedasticity	Chi-square	10.64	0.001
	BTC	Autocorrelation	Fisher	3449	0.000
		Heteroscedasticity	Chi-square	168.17	0.000
	ETH	Autocorrelation	Fisher	935.23	0.000
		Heteroscedasticity	Chi-square	187.25	0.000
	TEH	Autocorrelation	Fisher	24.89	0.001
		Heteroscedasticity	Chi-square	89.08	0.000
Argentina	GLD	Autocorrelation	Fisher	1194.38	0.000
		Heteroscedasticity	Chi-square	7.70	0.005
	BTC	Autocorrelation	Fisher	3449.26	0.000
		Heteroscedasticity	Chi-square	31.17	0.000
	ETH	Autocorrelation	Fisher	935.239	0.000
		Heteroscedasticity	Chi-square	156.43	0.000
	TEH	Autocorrelation	Fisher	24.898	0.001
		Heteroscedasticity	Chi-square	127.30	0.000
UK	GLD	Autocorrelation	Fisher	1194.38	0.000
		Heteroscedasticity	Chi-square	1.09	0.295
	BTC	Autocorrelation	Fisher	3449.26	0.000
		Heteroscedasticity	Chi-square	182.44	0.000
	ETH	Autocorrelation	Fisher	935.23	0.000
		Heteroscedasticity	Chi-square	182.44	0.000
	TEH	Autocorrelation	Fisher	24.898	0.001
		Heteroscedasticity	Chi-square	363.91	0.000
French	GLD	Autocorrelation	Fisher	1194.38	0.000
		Heteroscedasticity	Chi-square	0.41	0.520
	BTC	Autocorrelation	Fisher	3449.26	0.000
		Heteroscedasticity	Chi-square	156.02	0.000
	ETH	Autocorrelation	Fisher	935.239	0.000
		Heteroscedasticity	Chi-square	174.01	0.000
	TEH	Autocorrelation	Fisher	24.898	0.001
		Heteroscedasticity	Chi-square	214.87	0.000
Germany	GLD	Autocorrelation	Fisher	1194.38	0.000
		Heteroscedasticity	Chi-square	34.91	0.000
	BTC	Autocorrelation	Fisher	3449.26	0.000
		Heteroscedasticity	Chi-square	187.67	0.000
	ETH	Autocorrelation	Fisher	935.239	0.000
		Heteroscedasticity	Chi-square	378.85	0.000
	TEH	Autocorrelation	Fisher	24.898	0.000
		Heteroscedasticity	Chi-square	251.53	0.000
Hong-Kong	GLD	Autocorrelation	Fisher	1194.38	0.000
		Heteroscedasticity	Chi-square	17.07	0.000
	BTC	Autocorrelation	Fisher	3449.26	0.000
		Heteroscedasticity	Chi-square	63.61	0.000
	ETH	Autocorrelation	Fisher	935.23	0.000
		Heteroscedasticity	Chi-square	69.03	0.000
	TEH	Autocorrelation	Fisher	24.898	0.001
		Heteroscedasticity	Chi-square	255.37	0.000
KSA	GLD	Autocorrelation	Fisher	1194.38	0.000
		Heteroscedasticity	Chi-square	10.41	0.001
	BTC	Autocorrelation	Fisher	3449.26	0.000
		Heteroscedasticity	Chi-square	72.94	0.000
	ETH	Autocorrelation	Fisher	3449.26	0.000
		Heteroscedasticity	Chi-square	49.49	0.000
	TEH	Autocorrelation	Fisher	24.898	0.001
		Heteroscedasticity	Chi-square	211.50	0.000

BTC: Bitcoin, ETH: Ethereum, GLD: Gold

Table 5: Regression results for the USA

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	3.42e-05***	0.000501***	3.24e-05***	0
	(3.00e-06)	(3.22e-05)	(1.30e-06)	(1.02e-10)
NC	−0.00158***	0.0184***	−0.000568***	−1.17e-08
	(0.000254)	(0.00278)	(0.000112)	(8.84e-09)
TD	−0.0131	−0.0661	0.00602	6.56e-07**
	(0.00896)	(0.0984)	(0.00398)	(3.13e-07)
TH	−0.000152	0.00752*	0.000440***	−9.30e-09
	(0.000394)	(0.00413)	(0.000167)	(1.31e-08)
Constant	1,770***	7,159***	167.4***	1.002***
	(13.50)	(136.6)	(5.524)	(0.000435)
Observations	179	256	256	256
Number of id	1	1	1	1

Standard errors in parentheses. ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

Table 6: Regression results for Brazil

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	−1.57e-06**	0.00237***	0.000147***	−7.08e-11***
	(7.96e-07)	(8.37e-05)	(3.28e-06)	(0)
NC	0.000243*	−0.000652	−4.45e-05	1.16e-10
	(0.000130)	(0.00214)	(8.37e-05)	(4.40e-10)
TD	−0.00158**	0.0834**	0.000352	9.34e-10
	(0.000790)	(0.0346)	(0.00136)	(7.13e-09)
TH	−1.73e-06	0.00118	1.59e-05	1.04e-10
	(5.93e-06)	(0.000722)	(2.83e-05)	(1.49e-10)
Constant	1,835***	6,945***	−92.65***	1.002***
	(9.037)	(868.2)	(33.98)	(0.000179)
Observations	292	423	423	423
Number of id	1	1	1	1

Standard errors in parentheses, ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

Table 7: Regression results for Argentina

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	−1.57e-05***	0.00726***	0.000504***	−2.87e-10***
	(3.30e-06)	(0.000378)	(1.40e-05)	(9.24e-11)
NC	−0.000921	0.727***	0.0363***	6.87e-09
	(0.00115)	(0.118)	(0.00437)	(2.88e-08)
TD	0.237***	−19.62***	−0.559***	7.02e-07
	(0.0452)	(3.004)	(0.112)	(7.35e-07)
TH	0.00309***	−0.0728	−0.00521	1.46e-09
	(0.000789)	(0.0959)	(0.00357)	(2.35e-08)
Constant	1,773***	11,202***	83.12***	1.001***
	(7.110)	(803.8)	(29.91)	(0.000197)
Observations	363	522	522	522
Number of id	1	1	1	1

Standard errors in parentheses, ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

Conversely, the regressions on cryptocurrencies show that the two variables TCC and NC positively affect the prices of Bitcoin and Ethereum, whereas the variable TD is negatively associated with them. This suggests that Bitcoin and Ethereum are safe havens for Argentinian investors, as a decrease in TD leads to an increase in their prices. Finally, the last estimate shows a negative relationship between TCC and the price of Tether. This confirms the hypothesis that Tether is a safe haven cryptocurrency during crises.

4.4. The effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of the UK)

Table 8 presents the results of the estimates of the effects of the different variables associated with the COVID-19 pandemic on gold and cryptocurrency prices.

The first regression examines the effect of the different COVID-19 pandemic variables on the price of gold and the previously defined cryptocurrencies. We find that the TCC negatively affects the

gold price. However, the second and third regressions reveal a positive relationship between TCC and the price of Bitcoin and Ethereum. In other words, an increase in the TCC led to an increase in the prices of Bitcoin and Ethereum. This suggests that UK cryptocurrency investors believe that Bitcoin and Ethereum are safe havens in times of crisis. However, this finding does not hold for Tether.

4.5. The effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of France)

This subsection examines the effects of the COVID-19 pandemic on gold and cryptocurrency prices in France. Table 9 shows the results for the four estimates.

The above regressions examine the effect of the COVID-19 variables on the prices of gold and cryptocurrencies (Bitcoin, Ethereum, and Tether) in France. For the first and fourth regressions, we find negative and statistically significant coefficients at the 1% level associated with the variables TCC and TD (for the first estimation). This suggests that the easing of the COVID-19 pandemic encouraged French investors to move to gold and Tether, contrary to our initial hypothesis. However, we find a positive relationship between the variables representing the COVID-19 pandemic and Bitcoin and Ethereum. This finding confirms our basic hypothesis that investors prefer to invest in safe havens (gold and cryptocurrency) during crises.

4.6. The effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of Germany)

Next, we study the effect of the COVID-19 pandemic on gold and cryptocurrency prices in Germany. Table 10 presents the results of the different estimates.

The results of all four estimates reveal positive and statistically significant coefficients at the 1% threshold for the variables TCC and NC (except for Ethereum). In other words, an increase in the cumulative number of cases led to an increase in the prices of gold, Bitcoin, and Tether in Germany. This finding suggests that German investors tend to invest in cryptocurrencies during crises. As for TD, we observe a weak positive effect for gold and Tether but a strong negative relationship for Ethereum in the third estimate. Indeed, the coefficient associated with TD in regression 3 is negative and statistically significant at the 1% level. This implies that the more the TD in Germany decreased, the more investors tended to invest their money in Ethereum, which contradicts our basic hypothesis.

Table 8: Regression results for the UK

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	3.42e-05***	0.000501***	3.24e-05***	0
	(3.00e-06)	(3.22e-05)	(1.30e-06)	(1.02e-10)
NC	−0.00158***	0.0184***	−0.000568***	−1.17e-08
	(0.000254)	(0.00278)	(0.000112)	(8.84e-09)
TD	−0.0131	−0.0661	0.00602	6.56e-07**
	(0.00896)	(0.0984)	(0.00398)	(3.13e-07)
TH	−0.000152	0.00752*	0.000440***	−9.30e-09
	(0.000394)	(0.00413)	(0.000167)	(1.31e-08)
Constant	1,770***	7,159***	167.4***	1.002***
	(13.50)	(136.6)	(5.524)	(0.000435)
Observations	179	256	256	256
Number of id	1	1	1	1

Standard errors in parentheses. ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

Table 9: Regression results for France

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	−1.57e-06**	0.00237***	0.000147***	−7.08e-11***
	(7.96e-07)	(8.37e-05)	(3.28e-06)	(0)
NC	0.000243*	−0.000652	−4.45e-05	1.16e-10
	(0.000130)	(0.00214)	(8.37e-05)	(4.40e-10)
TD	−0.00158**	0.0834**	0.000352	9.34e-10
	(0.000790)	(0.0346)	(0.00136)	(7.13e-09)
TH	−1.73e-06	0.00118	1.59e-05	1.04e-10
	(5.93e-06)	(0.000722)	(2.83e-05)	(1.49e-10)
Constant	1,835***	6,945***	−92.65***	1.002***
	(9.037)	(868.2)	(33.98)	(0.000179)
Observations	292	423	423	423
Number of id	1	1	1	1

Standard errors in parentheses. ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

Table 10: Regression results for Germany

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	0.000459***	0.0119***	0.000677***	2.56e-07***
	(3.87e-05)	(0.000256)	(8.69e-06)	(1.77e-08)
NC	0.0355***	0.476***	0.00205	2.03e-05***
	(0.00905)	(0.0591)	(0.00201)	(4.09e-06)
TD	0.720*	2.655	−0.344***	0.000308*
	(0.402)	(2.327)	(0.0790)	(0.000161)
TH	0.000913	0.0728	0.00568***	1.39e-06
	(0.00697)	(0.0519)	(0.00176)	(3.59e-06)
Observations	346	504	504	504
Number of id	1	1	1	1

Standard errors in parentheses. ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

Table 11: Regression Results for India

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	−1.73e-07	0.00122***	7.23e-05***	−5.33e-11***
	(5.53e-07)	(6.04e-05)	(2.13e-06)	(0)
NC	−0.000444***	0.136***	0.00239***	2.74e-09
	(0.000127)	(0.0124)	(0.000436)	(2.54e-09)
TD	0.0173	−8.252***	−0.148***	4.47e-07*
	(0.0109)	(1.167)	(0.0411)	(2.39e-07)
TH	0.000412**	−0.0135	0.00217***	−7.13e-09*
	(0.000187)	(0.0187)	(0.000659)	(3.83e-09)
Constant	1,804***	11,753***	139.6***	1.002***
	(7.115)	(768.4)	(27.07)	(0.000158)
Observations	331	473	473	473
Number of id	1	1	1	1

Standard errors in parentheses. ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

4.7. The Effect of the COVID-19 Pandemic on Gold and the Cryptocurrency Market (the Case of India)

Table 11 presents the results of the estimates of the effects of the COVID-19 pandemic on gold and cryptocurrency prices in India.

The results of the first estimate of the impact of the different COVID-19 variables on the gold price show a negative and statistically significant coefficient at the 1% threshold for the variable NC, indicating that when the number of deaths decreases, the gold price increases. This result suggests that Indian investors are not interested in investing in gold and prefer cryptocurrencies. Moreover, there is a statistically significant and positive relationship at the 1% threshold for the variable TCC, suggesting that the higher the number of COVID cases, the more Indian investors tend to invest in cryptocurrencies. We notice that the number of COVID cases had a negative impact on Tether. However, the results show that TH is positively related to the prices of gold and Ethereum. This suggests that when the health situation in India improved in terms of the number of recoveries, investors moved towards gold and Ethereum, which is unexpected. The effect of TH on gold and cryptocurrencies can be explained by the fact that India experienced a health catastrophe following the Delta variant outbreak, which disrupted the entire country at all levels.

4.8. The effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of Hong Kong)

In the Asian context, we include a study on the impact of the COVID-19 pandemic on the prices of gold and cryptocurrency in Hong Kong. Table 12 presents the different results of the estimates.

Table 12: Regression results for Hong Kong

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	0.000986	4.014***	0.205***	−1.46e-07***
	(0.00128)	(0.0971)	(0.00562)	(4.25e-08)
NC	−0.639***	36.39***	2.787***	−1.43e-05***
	(0.170)	(12.28)	(0.711)	(5.38e-06)
TD	28.44***	−914.5*	−29.77	7.71e-06
	(6.914)	(531.5)	(30.78)	(0.000233)
TH	0.377	−33.04*	−3.345***	1.81e-05**
	(0.246)	(17.33)	(1.004)	(7.59e-06)
Constant	1,806***	−1,915**	−360.1***	1.002***
	(10.48)	(794.4)	(46.01)	(0.000348)
Observations	295	429	429	429
Number of id	1	1	1	1

Standard errors in parentheses, ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries.

In Hong Kong, the estimation results suggest that investors tended to invest in cryptocurrencies, such as Bitcoin and Ethereum, during crises. The coefficients associated with the variables TCC and NC are positive and statistically significant at the 1% threshold. This is corroborated by the variable TH, where the coefficients associated with this variable in regressions 2 and 3 are negative and statistically significant. In other words, as the TH increased, the intensity of cryptocurrency investments decreased, reinforcing the hypothesis that cryptocurrencies represent a safe haven for some categories of investors. However, the results of the last estimate contradict those of the previous regressions. We notice that both TCC and NC negatively affect the lagged price

Table 13: Regression results for KSA

Variables	(1)	(2)	(3)	(4)
	L.GLD	L.BTC	L.ETH	L.TEH
TCC	0.000225***	0.101***	0.00594***	−4.05e-09***
	(2.61e-05)	(0.00323)	(0.000181)	(7.95e-10)
NC	−0.0645***	9.332***	0.593***	−1.59e-07
	(0.00581)	(0.695)	(0.0388)	(1.71e-07)
TD	5.749***	−1,043***	−49.97***	2.12e-05*
	(0.407)	(50.35)	(2.814)	(1.24e-05)
TH	0.00707	−1.219**	−0.0664**	−5.33e-08
	(0.00509)	(0.597)	(0.0334)	(1.47e-07)
Constant	1,710***	3,574***	−488.1***	1.002***
	(10.20)	(1,246)	(69.65)	(0.000307)
Observations	329	481	481	481
Number of id	1	1	1	1

Standard errors in parentheses, ***P<0.01, **P<0.05, *P<0.1. BTC: Bitcoin, ETH: Ethereum, GLD: Gold, TCC: Total cumulative cases, NC: New cases, TD: Total deaths, TH: Total recoveries

of the cryptocurrency Tether. Therefore, when the number of new COVID-19 cases decreased, the price of Tether increased, which contradicts the hypothesis that this cryptocurrency represents a safe haven for investors during crises.

4.9. The effect of the COVID-19 pandemic on gold and the cryptocurrency market (the case of the Kingdom of Saudi Arabia)

After studying the effect of the COVID-19 pandemic on the value of gold and certain major cryptocurrencies in different contexts (American, European, and South and East Asian), we analyse this relationship in the context of a Middle Eastern and Arabian Gulf country, the Kingdom of Saudi Arabia (KSA). The Table 13 below shows the main results of this study.

The regression results show a positive effect of TCC on the prices of gold, Bitcoin, and Ethereum but not on the price of Tether. The coefficients associated with the variable TCC for the first three models are positive and statistically significant at the 1% threshold. Therefore, gold, Bitcoin, and Ethereum are safe havens for Saudi Arabian investors. In other words, an increase in the number of COVID-19 cases led to an increase in the prices of gold and the two aforementioned cryptocurrencies. This was not the case for Tether, which the authors consider the safest cryptocurrency during crises. Furthermore, TD is negatively associated with Bitcoin and Ethereum, which rejects the initial hypothesis and contradicts the results of the first two variables in the model (TCC and NC). This may have been due to the small sample size. Finally, the variable TH is not statistically significant for the first estimate, which focuses on the value of gold. However, it is statistically significant for the second and third estimates, which concern the lagged prices of Bitcoin and Ethereum, respectively. When the average number of people cured of COVID-19 in Saudi Arabia dropped, Saudi investors tended to invest their money in safe havens such as Bitcoin and Ethereum.

5. CONCLUSION

New economic phenomena and practices tend to emerge during global crises. With the emergence of the cryptocurrency market, many investors and financial market speculators have turned to cryptocurrencies because of the high volatility of the market. Indeed, Caferra et al. (2021) find a significant relationship between the US stock market and the cryptocurrency market using a wavelet method to study co-movements between the two markets. Additionally, the market capitalisation of cryptocurrency has exploded owing to several factors, including the COVID-19 pandemic. This has led some investors to prefer investing in cryptocurrencies. Consequently, the weight of cryptocurrency in portfolios built since the outbreak of the pandemic has been very high (Li and Meng, 2022). Furthermore, several authors have found that Tether is the most stable and competitive cryptocurrency against gold during the COVID-19 pandemic. In our study, the results regarding the relationship between the pandemic variables and lagged stock prices of gold and different cryptocurrencies varied by country and continent. This is likely due to several factors, such as the strength of the health system, culture, freedom of speech, and political regimes. For example, democratic countries such as the US and UK witnessed an explosion in COVID-19 cases and deaths despite their strong health systems.

We found a positive and statistically significant relationship between Bitcoin and Ethereum, on the one hand, and COVID-19 variables during the pandemic, on the other hand. However, we did not find a significant relationship between Tether and the COVID-19 variables. We found similar results for Latin American countries such as Brazil and Argentina. In other words, the prices of Bitcoin and Ethereum react positively to the variables that represent the COVID-19 pandemic. Conversely, we found a negative and significant relationship between gold and Tether, on the one hand, and the COVID-19 pandemic, on the other hand.

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