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Cryptocurrency Risks, Fraud Cases, and Financial Performance

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Abstract: In this study, we examine major cryptocurrencies, present notable fraud cases, describe fraud risks, and analyze cryptocurrency financial performance. People debate whether cryptocurrency is an investment opportunity, the new Dutch Tulip Bubble, or a giant Ponzi scheme. There have been a number of high-profile fraud cases associated with cryptocurrencies, such as the FTX scandal in late 2022, thereby making fraud a real concern to current and potential future investors. Regarding financial performance, cryptocurrencies experienced a major collapse in value in the most recent period of the study, about three times worse than the major stock market indices. While in prior periods, cryptocurrencies have significantly outperformed stock market indices, recent fraud cases and the extreme volatility of cryptocurrencies indicate that investing in cryptocurrencies comes with much higher risk than traditional stock market investments. The debate over the investment potential of cryptocurrencies continues, whether they have long term value or are simply the new Dutch Tulip Bubble. The study's findings will be useful to investors, regulators, and academic researchers regarding the cryptocurrency industry.

Keywords: cryptocurrency; Bitcoin; fraud risk; financial investment; Ponzi scheme

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1. Introduction

In this study, we report on major cryptocurrencies, describe notable fraud cases, present fraud risks, and examine cryptocurrency financial performance. The value of cryptocurrency has been debated, advocates calling it a viable investment opportunity and critics calling it the new Dutch Tulip Bubble and a giant Ponzi scheme. A review of the high-profile fraud cases associated with cryptocurrencies is a cause for concern to current and future potential investors.

While cryptocurrencies have sometimes generated high returns in past years, investors know that historical financial performance does not always predict future performance. To evaluate financial performance, this study examines two recent years of financial performance of major cryptocurrencies. These findings will be useful to investors, regulators, and academic researchers regarding the cryptocurrency industry.

This study proceeds with the following sections. In the second section below, an overview of the background of major cryptocurrencies is presented. In the third section, notable cryptocurrency fraud cases and fraud risks are reviewed. In the fourth section, a financial performance analysis is made of a sample of cryptocurrencies relative to major stock indices. Last, conclusions are provided.

2. Background on Major Cryptocurrencies

Cryptocurrency is a type of digital currency in the form of tokens, or "coins", that can be purchased as an investment or used to purchase goods or services from vendors that accept cryptocurrency. Some cryptocurrency exchanges offer users the ability to convert government-backed currency to cryptocurrency and vice versa. Some exchanges also offer digital wallet services where users can store their cryptocurrency securely online in the form of an encrypted hash value (Astrakhantseva et al. 2021). While their use as an actual currency, for buying and selling products and services, is almost nil, their use as an investment vehicle is very real:

"[Bitcoin] has become a speculative investment. This is puzzling. It has no intrinsic value and is not backed by anything. Bitcoin devotees will tell you that, like gold, its value comes from its scarcity... But scarcity by itself can hardly be a source of value. Bitcoin investors seem to be relying on the greater fool theory—all you need to profit from an investment is to find someone willing to buy the asset at an even higher price" (Prasad 2021).

Cryptocurrency transactions are executed through peer-to-peer networks, and records of these transactions are maintained in a decentralized digital ledger called a blockchain. The blockchain is maintained on many different computers around the world, which facilitates the security of cryptocurrency transactions. Transactions require the use of both a private key and a public key, which are used by the sender to prove they own the cryptocurrency being transferred and to stipulate who should receive the cryptocurrency. A private key is similar in concept to a password and is needed to access the user's digital wallet where cryptocurrency is stored, and a public key is conceptually similar to an address where cryptocurrency is to be sent. Transactions are pseudo-anonymous in that the parties to each transaction are identified by hashes of their public keys rather than by usernames (Trozze et al. 2022; Federal Bureau of Investigation 2021).

Bitcoin is one cryptocurrency. While there are thousands of cryptocurrencies, the top five in terms of market capitalization as of August 2022 were Bitcoin, Ethereum, Tether, U.S. Dollar Coin, and Binance Coin. (Tretina 2022, August). We discuss each of those cryptocurrencies below.

Bitcoin

Bitcoin is the oldest and most popular cryptocurrency in use today, but it was not the first cryptocurrency. That distinction belongs to eCash, which was conceived by David Chaum in a paper published in 1983 and later developed in 1990 through his company DigiCash (Chaum 1983). DigiCash declared bankruptcy in 1998, but Chaum's ideas remained instrumental in the development of subsequent cryptocurrencies.

The term "bitcoin" first appeared in a whitepaper written by a person or group using the name Satoshi Nakamoto. The paper was published in 2008 under the title "Bitcoin: A Peer-to-Peer Electronic Cash System" (Nakamoto 2008). In that paper, the author(s) described several key features related to the operation of cryptocurrency, including:

a. Electronic cash that can be used to make online payments directly from one party to another;
b. Electronic coins based on a chain of digital signatures that enable verification of the chain of ownership;
c. Electronic payment systems based on cryptographic proof instead of trust;
d. Decentralization of transactions via peer-to-peer networks instead of through financial institutions such as banks. The peer-to-peer networks use timestamped transactions to create a chain of proof-of-work, thereby forming a public record (i.e., a "blockchain") of the history and chronological order of transactions.

The first commercial transaction using Bitcoin occurred in 2010 when 10,000 Bitcoin were used to purchase two Papa John's pizzas. At that time, the 10,000 Bitcoin used to purchase the pizzas were worth an estimated USD 41; however, at the time of this writing, their value would be approximately USD 210, 624,000 (USD 21,624 per Bitcoin). A Bitcoin in and of itself has no intrinsic value and is not tied to the value of any government-issued currency

or security. In fact, the value of one Bitcoin has been extraordinarily volatile, ranging from less than one cent in 2010 to its peak of about USD 69,000 in November 2021 with several significant spikes and slumps during that period (Kamau 2022). Since the creation of Bitcoin, many other cryptocurrencies have appeared that are based on concepts and technology similar to those of Bitcoin.

Ethereum

Like Bitcoin, Ethereum is a decentralized digital currency platform whose currency, known as Ether, has no intrinsic value, has no centralized issuer, and uses blockchain technology to record transaction history. However, unlike Bitcoin, Ethereum goes further by allowing transactions not only via cryptocurrency but also through "smart contracts" that enable parties to exchange anything of value without the need for the services of a lawyer or a notary (Zapotochnyi 2022).

Founded in 2015 by Vitalik Buterin, Ethereum has since grown to become the second-largest cryptocurrency platform in the world. Along the way, however, Ethereum has experienced some significant growing pains, including a 2016 theft of Ether worth $50 million by an anonymous hacker, resulting in concerns about the platform's security (Leising 2017). Like Bitcoin, the price of Ether has exhibited extreme instabilities. For instance, the beginning of 2021 saw Ether prices around USD 750. By November 2021, the price had risen to an all-time high of USD 4867, an increase of over 500 percent in less than a year.

Tether

Tether, which was originally called "Realcoin", was founded in 2014 in Santa Monica and is currently owned by Hong Kong-based firm iFinex, Inc. The Tether cryptocurrency appeals to many investors by virtue of it being one of the first "stablecoin" cryptocurrencies. Issuers of stablecoins seek to correlate their market price with a government-issued currency or other independent point of reference, thereby reducing the price volatility inherent in other types of cryptocurrency. In Tether's case, its price is tied primarily to the value of the U.S. dollar (Casey 2014).

Tether's history has not been without controversy. In 2017, Tether tokens worth USD 31 million were stolen from Tether's digital vault and transferred to an unauthorized bitcoin address by a hacker, raising concerns about the platform's security. In 2021, Tether was fined USD 41 million by the U.S. Commodity Futures Trading Commission (CFTC) over claims that Tether was fully backed by U.S. dollars when, according to the CFTC, "Tether held sufficient fiat reserves in its accounts to back USDT tether tokens in circulation for only 27.6% of the days in a 26-month sample time period from 2016 through 2018" (Commodity Futures Trading Commission 2021; Schroeder 2017).

USD Coin

Similar to Tether, USD Coin is a stablecoin cryptocurrency. Its value is tied to and backed by the U.S. dollar, and holders of USD Coin can redeem one USD Coin for USD 1.00. As a stablecoin cryptocurrency, one of its primary purposes is to provide investors with value stability rather than value appreciation. As of this writing, its daily close price over the preceding 52-week period has not dropped below USD 0.998 nor risen above USD 1.002. Unlike Tether, which is renowned for its failure to have its reserves audited by professional independent auditors, USD Coin's reserves are reviewed monthly by the accounting firm Grant Thornton LLP (Bhattacharya 2021; Commodity Futures Trading Commission 2021).

Binance

The world's largest cryptocurrency exchange in terms of daily trading volume is Binance (Statista 2022). Binance issues two cryptocurrencies, BNB and BUSD. Binance's relatively low transaction fees and the ability to earn a Binance Coin as a reward for recommending Binance to other people have helped boost its popularity. On the downside, some people regard Binance as difficult to use, and people in the United States cannot use the Binance platform, as it has been legally banned in the U.S. since 2019. U.S. citizens, however, can

access Binance US, which is a different and more limited exchange than Binance. Businessweek reports that U.S. regulators, including the Securities and Exchange Commission, Department of Justice, and Internal Revenue Service, were investigating Binance US and Binance for money laundering and fraud as recently as June 2022 (Davidson 2022; Lee and Chafkin 2022).

3. Fraud Cases and Fraud Risks Involving Cryptocurrencies

The use of cryptocurrency has increased significantly in recent years, and continued record growth is expected. Chainalysis, Inc., a New York-based research firm focusing on blockchain data and cryptocurrency, reported that total cryptocurrency transaction volume grew to USD 15.8 trillion in 2021, an increase of 567 percent from 2020. In lockstep with the growth in cryptocurrency usage, there has been an increase in the volume of illicit activity involving cryptocurrency. In 2021, USD 14 billion worth of cryptocurrency was obtained by cybercriminals through a variety of cybercrimes (Chainalysis 2022a).

Chainalysis conducted a survey of 300 law enforcement professionals employed by U.S. federal, state, and local law enforcement agencies. The survey's results, which were released in 2022, indicate that cryptocurrency is prevalent in a wide range of criminal activities. Table 1 shows the relative frequency of various types of crimes associated with cryptocurrency as reported by survey respondents employed at state or local agencies.

Table 1. Relative frequency of crimes associated with cryptocurrency.

Types	Percentage of Crime
Fraud/scams (e.g., investment, wire, romance, COVID-19)	46.0%
Ransomware/other cybercrimes	24.4%
Theft of cryptocurrency	12.2%
Drugs	11.7%
Child sexual abuse material	3.6%
Kidnapping	1.4%
Homicide	0.9%

Adapted from: Chainalysis (2022b).

As shown in Table 1, the most frequently observed types of crime involving cryptocurrency are fraud schemes/scams (46%), followed by ransomware/other cybercrimes (24.4%), cryptocurrency theft (12.2%), and transactions involving illegal drugs (11.7%). A similar pattern of results was observed in responses from employees of federal agencies.

Cryptocurrency is also referred to as cybercurrency. The term "cyberspace" is often used to refer to any feature or facility that is connected to the Internet. Processing cryptocurrency transactions with miners is only possible via internet-enabled devices. The world of cyberspace has become increasingly complex over the time since science-fiction writer William Gibson coined the term in the early 1980s (Technopedia 2022; Smith et al. 2015). This complexity, while often necessary, may lead to obfuscation and unintentional errors, but also can be manipulated to cover up fraud. Complexities and misunderstandings are an aspect of errors and fraud regarding cryptocurrency.

Cyber technologies have been extensively used to advance business operations, such as using social media to promote firm products and services (cf., Loveland et al. 2019a, 2022; Smith et al. 2019a; Smith and Smith 2019; Chamberlain et al. 2018), to facilitate employee searches (Loveland et al. 2019b), to foster accounting and financial reporting (e.g., Efendi et al. 2011, 2014), and to improve auditing (Kend and Nguyen 2020; Warren and Smith 2006). In the early day of e-commerce, researchers identified cyber-specific risks and evaluated the steps taken to prevent and minimize their impact (cf., Smith et al. 2019b; Smith and Lin 2011; Kratchman et al. 2008; Runyan et al. 2008). In particular, cybersecurity and fraud have become a major issues for modern business firms (e.g., Mulig et al. 2014; Efendi et al. 2006).

Likewise, cybersecurity and fraud are poignant concerns to cryptocurrency providers and investors.

Cryptocurrency Fraud/Scams

Illegal cryptocurrency activity is occurring more frequently than ever, particularly cryptocurrency scams and theft, with their perpetrators employing increasingly innovative methods to cover their activities. For instance, Chainalysis reports that losses from scamming schemes rose 82 percent in 2021 to USD 7.8 billion of cryptocurrency stolen from victims. Over 35 percent of the USD 7.8 billion stolen was the result of rug pulls, a term used to describe a relatively new type of scam involving cryptocurrency. In a rug pull, developers attract investors with promises of a lucrative new cryptocurrency venture, but then the developers pull out before the project is completed and disappear with the investors' money (Chainalysis 2022a; The Economic Times 2022). According to the Federal Trade Commission (FTC), "nearly half the people who reported losing crypto to a scam since 2021 said it started with an ad, post, or message on a social media platform", most of which involved bogus investment opportunities (i.e., investment scams). The top social media platforms used to facilitate cryptocurrency fraud are Instagram (32%), Facebook (26%), WhatsApp (9%), and Telegram (7%) (Fletcher 2022).

High-yield investment scams (Ponzi schemes) are another technique used by cybercriminals to steal funds involving cryptocurrency. Victims of these schemes are paid returns on their investments with funds invested by a diminishing supply of new victims, with little or no returns received from actual investments. For instance, in 2021, a Las Vegas mother and son team stole more than USD 12 million from 277 investors after promising them extraordinary returns of 20 to 30 percent per year from investments in cryptocurrencies and securities. However, very little money came from investments in cryptocurrencies or securities; instead, nearly all of the funds came from the investors themselves in what amounted to a classic Ponzi scheme (Woolley and Wells 2021).

Another example of a high-yield investment scam associated with cryptocurrency involved Finiko, a Russia-based financial consulting firm. From December 2019 to July 2021, Finiko lured investors to invest with either Bitcoin or Tether by promising monthly returns as high as 30 percent. During that 19-month period, the scheme duped investors in Russia and Ukraine of over USD 1.5 billion worth of Bitcoin. In addition, there is evidence to indicate that Finiko was involved in laundering cryptocurrency worth millions of dollars obtained through ransomware and other forms of cybercrime (Chainalysis 2022a).

The largest high-yield investment scam involving cryptocurrency was the bankruptcy and collapse of FTX, a Bahamas-based cryptocurrency exchange. Before collapsing near the end of 2022, FTX was one of the largest cryptocurrency exchanges, with more than one million users. A news story by Reuters indicated that over USD 1 billion of consumer funds were unaccounted for (Berwick 2022). In the aftermath of the FTX collapse, Joe Lonsdale, a co-founder of software company Palantir, observed: "most of what we saw in crypto the last three, four, five years was a speculative bubble driven by cheap money and driven by a lot of these Ponzi schemes" (Raasch 2022, p. 1).

Speaking to a Senate Banking, Housing, and Urban Affairs Committee in December 2022, Ben McKenzie Schenkkan referred to the cryptocurrency industry as a fraud and a gigantic Ponzi scheme. Schenkkan, an actor celebrity with an economics degree, had previously condemned other celebrities for doing ads to promote cryptocurrencies. The Senate Committee is considering how to regulate the cryptocurrency industry, as a result of the FTX bankruptcy and criminal charges facing Sam Bankman-Fried, FTX founder. According to Schenkkan, cryptocurrency investors "have been lied to in ways both big and small, by a once seemingly mighty crypto industry whose entire existence, in fact, depends on misinformation, hype, and yes, fraud" (Pandolfo 2022, p. 1).

When cryptocurrencies began rapidly increasing in value, some people made comparisons to the Dutch Tulip Bulb Bubble, which occurred in Holland from 1633 to 1637. The tulip trade had been limited to professional tulip growers, but ever-rising prices caused many

middle-class and poor people to invest in the tulip bulb market. People even mortgaged their homes and businesses to buy tulip bulbs. The sale and resale of bulbs led to higher and higher prices. In early 1637, people started questioning whether prices could keep going up. Virtually overnight, prices collapsed, resulting in a financial catastrophe for numerous Dutch citizens (Encyclopaedia Britannica 2022).

There was nothing necessarily fraudulent about the tulip bulb bubble, just an enormous demand for an innocuous product, akin to the American consumer frenzy to buy Pet Rocks in 1975–1976 and Cabbage Patch Dolls in the early 1980s. When consumer demand vanished, the products themselves had little or no intrinsic value. However, most families purchased only a few rocks or dolls, and generally did not consider either as an actual investment, so there were no significant consequences when the demand evaporated. On the other hand, if people buy cryptocurrency as an investment, which then goes to zero value, then there could be significant consequences. For this reason, the Governor of the Reserve Bank of India, Shaktikanta Das, condemned "cryptocurrencies as 'a big threat to the country's financial and macroeconomic stability' and a trap for unwary investors. 'Cryptos have no underlying asset, not even a tulip'" (Aiyar 2022, p. 1). Koutmos (2022) indicates that cryptocurrency prices could be the result of irrationality and be comparable to historical financial bubbles. Investment advisor and media celebrity, Jim Kramer calls the cryptocurrency market a true sham (Pan 2023).

Cryptocurrency fraud schemes/scams also include romance scams in which the fraudster gains a victim's trust through a romantic relationship and uses that trust to obtain money/cryptocurrency. According to the FTC, cryptocurrency losses of USD 185 million related to romance scams were reported between January 2021 and March 2022, with a median individual loss of USD 10,000. Similar to romance scams, business and government impersonation scams resulted in losses of USD 133 million from January 2021 to March 2022. For instance, the FTC reported, in May 2021, that cryptocurrency worth USD 2 million had been transferred to Elon Musk impersonators during the preceding six months (Fletcher 2022; Povich 2021).

Other types of cryptocurrency fraud schemes/scams include exchange scams, scam wallets, mining scams, scams related to COVID-19, bogus cryptocurrency investment apps, and pump-and-dump schemes. Below is a summary of each:

Exchange scams involve cybercriminals opening a fraudulent cryptocurrency exchange service, enticing victims to purchase cryptocurrency through the exchange, and then closing the exchange and absconding with the victims' money.

Scam wallets are fraudulent cryptocurrency wallets used by cyber criminals to illicitly draw away some or all of the cryptocurrency transferred to them by victims.

Mining scams involve promises of high returns to lure victims to invest in cryptocurrency mining operations, but victims rarely receive a payout from their investments.

COVID-related scams typically require payment in cryptocurrencies for purchases of personal protective equipment or for donations (Trozze et al. 2022).

Fraudulent cryptocurrency investment apps and websites are created by cyber criminals using the names and/or logos of legitimate companies to attract investors under the pretense of providing authentic cryptocurrency investment services. The FBI estimates that, as of mid-2022, U.S. investors had lost USD 42.7 million resulting from the use of such apps (Federal Bureau of Investigation 2022).

Pump-and-dump schemes involving cryptocurrencies are becoming widespread. In 2018, Feder et al. (2019) identified more than 4800 different pump signals transmitted on two popular group messaging platforms—Telegram and Discord—during a six-month period promoting more than 300 cryptocurrencies. The pumps were quite successful and profitable. Within five minutes, the median price of the cryptocurrencies being pumped increased by 3.5% (4.8%) for pumps on Discord (Telegram) for cryptocurrencies with relatively high trading volumes (Bitcoin is ranked #1), and 23% (19%) on Discord (Telegram) for less popular coins.

Wire fraud is almost always a component of these cryptocurrency fraud schemes/scams, and perpetrators can be prosecuted under wire fraud statutes. Not limited to cybercrimes, wire fraud consists of "having devised or intending to devise any scheme or artifice to defraud, or for obtaining money or property by means of false or fraudulent pretenses, representations, or promises, transmits or causes to be transmitted by means of wire, radio, or television communication in interstate or foreign commerce, any writings, signs, signals, pictures, or sounds for the purpose of executing such scheme or artifice" (US Code 2023).

Much of the fraud-related activity involving cryptocurrencies occurs on the Darknet. Revenue generated by markets on the Darknet has grown steadily since 2012, reaching a new high in 2021 of USD 2.1 billion in cryptocurrency. Approximately USD 300 million of the USD 2.1 billion was obtained by "fraud shops" through the sale of illicit products, such as stolen credit card numbers, login credentials, and exploit kits, while the balance of USD 1.8 billion was generated by Darknet drug markets (Chainalysis 2022a).

Cryptocurrency and Ransomware

The amount of cryptocurrency extorted in ransomware attacks has increased dramatically since 2016, when total cryptocurrency payments from ransomware victims were estimated to be USD 24 million. By 2020, that figure had grown to USD 692 million. By mid-2022, USD 602 million of cryptocurrency payments made in 2021 had been identified, but that figure is expected to increase significantly as previously unidentified payments are discovered. The average ransomware payment has also been increasing. In 2019, the average payment was USD 25,000. In 2020, it was USD 88,000, and by 2021, the average had grown to over USD 118,000 (Ibid.).

As of 2022, 140 ransomware strains are known to have been used successfully to extort payments from victims. Two strains of ransomware are particularly noteworthy. Russia-based Conti was used in 2021 to extort cryptocurrency worth approximately USD 175 million from its victims, the most of all ransomware strains. Conti is based on the ransomware-as-a-service model, enabling relatively unsophisticated cybercriminals to use Conti for a fee to launch ransomware attacks. The second highest-ranked strain of ransomware in terms of funds extorted is DarkSide, which was used in 2021 to extort approximately USD 80 million. The DarkSide strain gained notoriety in 2021 when it was used to shut down the operations of the U.S. Colonial Pipeline for one week, causing disruptions of fuel supplies in some U.S. states. Operations resumed after Colonial's CEO paid USD 4.4 million in Bitcoin to DarkSide, USD 2.3 million of which was subsequently recovered by the U.S. Department of Justice (Chainalysis 2022a; Zafft 2021).

Cryptocurrency Theft

Regarding cryptocurrency theft, digital thieves appear to have stolen USD 3.2 billion in cryptocurrency from individuals and services in 2021, which is a 516 percent increase in the amount stolen in 2020. Of the USD 3.2 billion, over 70 percent was stolen from decentralized finance (DeFi) platforms. DeFi platforms are relatively new entities that enable people to engage directly in financial transactions using cryptocurrency and blockchain networks without the need to go through centralized exchanges or traditional financial services organizations such as banks. Prior to 2021, cryptocurrency theft was primarily associated with centralized exchanges. However, in 2021, losses from DeFi platform thefts increased 1330 percent relative to the prior year and were six times greater than losses from centralized exchanges (Chainalysis 2022a).

Cryptocurrency and Money Laundering

Money laundering is defined by the UN Vienna Convention as:

> "the conversion or transfer of property, knowing that such property is derived from any offense(s), for the purpose of concealing or disguising the illicit origin of the property or of assisting any person who is involved in such offense(s) to evade the legal consequences of his actions." (United Nations Office on Drugs and Crime n.d.)

One thing that all criminals involved in illegal cyber activities involving cryptocurrencies have in common is the need to conceal or disguise their stolen funds from the authorities and convert it to cash that appears to have come from legal activities. Thus, money laundering is essential to all types of cybercrimes involving cryptocurrency.

Since 2017, cryptocurrency worth more than USD 33 billion has been laundered. In 2021 alone, cryptocurrency worth approximately USD 8.6 billion was laundered, which is an increase of USD 2 billion compared to 2020. However, the laundering of government-issued currency still exceeds that of cryptocurrency by several orders of magnitude, as estimates place the value of government-issued currency laundered annually worldwide to be between USD 800 billion and USD 2 trillion (Chainalysis 2022a; United Nations Office on Drugs and Crime n.d.).

4. Analysis of Financial Performance by Major Cryptocurrencies

In this section, we examine cryptocurrency's financial performance. Our examination involves a comparison of the major cryptocurrencies to major US stock indexes. Our definition of a "major cryptocurrency" is any cryptocurrency with a market cap of at least USD 1 billion (USD) on 1 October 2022. The major stock indexes included are the Dow Jones (DJIA), the Standard and Poor's 500 Index (S&P 500), the Nasdaq Composite Index (Nasdaq), and the Russell 2000 (Russell 2000).

The DJIA is the most popular index. The Dow tracks the performance of 30 "blue-chip" companies trading on the New York Stock Exchange (NYSE) or Nasdaq. This price-weighted index is a broad measure of the overall health of the U.S. economy (Biktimirov and Xu 2019). In addition to serving as a measure of the economy, it also represents an income-oriented investment strategy since the DJIA includes companies that pay regular and consistent dividends.

The S&P 500 includes the top 500 U.S. stocks based primarily on market capitalization. This market-weighted index indicates overall movement in the U.S. market (Hsu 2021). Since the S&P 500 represents nearly 80% of the value of the U.S. stock market, we selected this index to represent the market as a whole.

The Nasdaq is an index of all stocks traded on the Nasdaq stock exchange (Gómez-Martínez et al. 2022). Like the S&P 500, the Nasdaq is a market-weighted index. However, while the S&P 500 considers other factors in its decision to include a stock in its index, the Nasdaq is solely based on market capitalization. This index is widely viewed as a measure of the technology sector of the economy (Gómez-Martínez et al. 2022). We selected this index because it represents investors' perspectives on more risky stocks.

The Russell 2000 tracks 2000 small-cap U.S. companies. This index is commonly used to assess the performance of small-cap mutual funds (Cremers et al. 2020). We included this measure because it focuses on the performance of companies that are too small to be included in the DJIA or S&P 500 while eliminating the bias toward extremely large companies (such as Apple) included in the Nasdaq.

To analyze the financial performance of major cryptocurrencies, we compiled price data available through Yahoo! Finance. To reduce the unusual volatility in financial markets in early 2020 due to the COVID-19 pandemic lockdowns, and to provide the most recent data available for our study, we examined historical data from the start of the fourth quarter of 2020 through the start of the fourth quarter of 2022. To ensure complete data for our analysis, we eliminated any cryptocurrency that had an ICO (initial coin offering) during the study period. In addition, we eliminated any cryptocurrency with a price below USD 0.01 (USD) at any time during the study period. The final data set included 40 major cryptocurrencies.

Table 2 lists the major cryptocurrencies in our study ranked by market capitalization at the beginning of the fourth quarter of 2022. In addition to displaying the opening price at the start of the fourth quarter for 2020, 2021, and 2022, the table also shows the percentage change in price from Q4 2020 to Q4 2021 (hereinafter referred to as Year 1) and from Q4 2021 to Q4 2022 (hereinafter referred to as Year 2).

Table 2. Cryptocurrency prices.

Rank (By Mkt. Cap)	Ticker (-USD)	Crypto (USD)	Q4 2020 Open (USD)	Q4 2021 Open (USD)	Q4 2022 Open (USD)	Year 1 % Change	Year 2 % Change
1	BTC	Bitcoin	10,795.25	43,816.74	19,431.11	305.9	−55.7
2	ETH	Ethereum	360.31	3001.13	1328.19	732.9	−55.7
3	USDT	Tether	1.00	1.00	1.00	0.0	0.0
4	BNB	Binance Coin	29.32	387.64	284.27	1222.1	−26.7
5	USDC	USD Coin	1.00	1.00	1.00	0.0	0.0
6	XRP	XRP	0.24	0.95	0.48	295.8	−49.5
7	BUSD	Binance USD	1.00	1.00	1.00	0.0	0.0
8	ADA	Cardano	0.10	2.12	0.43	2020.0	−79.7
9	SOL	Solana	2.90	141.38	33.22	4775.2	−76.5
10	MATIC	Polygon	0.02	1.13	0.78	5550.0	−31.0
11	DOT	Polkadot	4.35	28.62	6.31	557.9	−78.0
12	DAI	Dai	1.01	1.00	1.00	−1.0	0.0
13	TRX	TRON	0.03	0.09	0.06	200.0	−33.3
14	AVAX	Avalanche	4.32	66.63	17.20	1442.4	−74.2
15	UNI1	Uniswap	4.01	23.54	6.45	487.0	−72.6
16	WBTC	Wrapped Bitcoin	10,790.28	43,763.27	19,428.52	305.6	−55.6
17	LEO	UNUS SED LEO	1.28	2.83	4.19	121.1	48.1
18	LTC	Litecoin	46.43	153.29	53.40	230.2	−65.2
19	ETC	Ethereum Classic	5.40	47.04	27.73	771.1	−41.1
20	LINK	Chainlink	9.87	24.01	7.58	143.3	−68.4
21	ATOM	Cosmos	5.38	36.23	13.02	573.4	−64.1
22	FTT	FTX Token	3.66	51.68	24.24	1312.0	−53.1
23	XLM	Stellar	0.07	0.28	0.11	300.0	−60.7
24	CRO	Cronos	0.15	0.16	0.11	6.7	−31.3
25	XMR	Monero	108.51	251.10	147.32	131.4	−41.3
26	ALGO	Algorand	0.35	1.63	0.35	365.7	−78.5
27	BCH	Bitcoin Cash	228.22	502.85	120.02	120.3	−76.1
28	BTCB	Bitcoin BEP2	10,932.13	43,794.70	19,438.99	300.6	−55.6
29	VET	VeChain	0.01	0.10	0.02	900.0	−80.0
30	QNT	Quant	8.42	290.22	141.95	3346.8	−51.1
31	FIL	Filecoin	22.24	60.05	5.68	170.0	−90.5
32	HBAR	Hedera	0.03	0.34	0.06	1033.3	−82.4
33	XTZ	Tezos	2.25	6.08	1.42	170.2	−76.6
34	CHZ	Chiliz	0.01	0.26	0.23	2500.0	−11.5
35	EGLD	Elrond	10.36	209.98	47.47	1926.8	−77.4
36	MANA	Decentraland	0.08	0.69	0.70	762.5	1.4
37	SAND	The Sandbox	0.05	0.67	0.84	1240.0	25.4
38	WBNB	Wrapped BNB	29.30	385.72	283.86	1216.5	−26.4
39	EOS	EOS	18.59	23.24	15.30	25.0	−34.2
40	THETA	Theta Network	0.75	5.05	1.07	573.3	−78.8
		AVERAGE				903.4%	−46.4%

DATA SOURCE: Yahoo! Finance, retrieved from https://finance.yahoo.com/crypto/, accessed on 10 February 2022. NOTE: "Year 1" refers to the period from Q4 2020 to Q4 2021 and "Year 2" refers to the period from Q4 2021 to Q4 2022.

On average, the major cryptocurrencies in our study demonstrated price gains of over 900% during Year 1. Polygon (MATIC) experienced the largest gain at over 5500 percent with

Dai (DAI) suffering the only loss of value (1% decrease in price). During Year 2, the major cryptocurrencies suffered an average loss of 46.4%. Only three cryptocurrencies, Decentraland (MANA), The Sandbox (SAND), and UNUS SED LEO (LEO), experienced a gain during Year 2 while Filecoin (FIL) lost more than 90% of its value.

Table 3 shows the value of each major index at the start of the fourth quarter of 2020–2022 and the percentage change in value for Year 1 and Year 2. Index values are retrieved from Yahoo! Finance (2022).

Table 3. Major market indices.

Ticker (-USD)	Market Index	Q4 2020 Open (USD)	Q4 2021 Open (USD)	Q4 2022 Open (USD)	Year 1 Change	Year 2 Change
DJI	Dow Jones Industrial Average	27,940.63	33,930.70	28,725.51	21.4%	−15.3%
IXIC	NASDAQ Composite	11,291.99	14,494.93	10,575.62	28.4%	−27.0%
GSPC	S&P 500	3385.87	4317.16	3585.62	27.5%	−16.9%
RUT	Russell 2000	1508.60	2205.91	1664.72	46.2%	−24.5%
	AVERAGE				30.9%	−21.0%

DATA SOURCE: Yahoo! Finance. NOTE: "Year 1" refers to the period from Q4 2020 to Q4 2021 and "Year 2" refers to the period from Q4 2021 to Q4 2022.

On average, the market indexes realized a gain in value of just over 30% in Year 1 followed by a loss of value of nearly 21% in Year 2. In Year 1, the Russell 2000 gained the most, suggesting that smaller companies recovered faster after COVID-19 lockdowns. However, it also showed the second-highest decline after Nasdaq in Year 2. Overall, the DJIA was the least volatile with the lowest gain (from Q4 2020 to Q4 2021 and the smallest decline from Q4 2021 to Q4 2022).

The next step in our analysis was to identify the highest and lowest price for each cryptocurrency during Year 1 and Year 2. We then calculated the high/low ratio for each year to serve as a measure of risk. These calculations appear in Table 4.

Table 4. Cryptocurrencies high/low ratios.

Rank (By Mkt. Cap)	Ticker (-USD)	Crypto (USD)	Year 1 High/Low Ratio	Year 2 High/Low Ratio
1	BTC	Bitcoin	6.23	3.88
2	ETH	Ethereum	13.04	5.46
3	USDT	Tether	1.04	1.08
4	BNB	BNB	26.69	3.63
5	USDC	USD Coin	1.04	2.35
6	XRP	XRP	11.53	4.66
7	BUSD	Binance USD	1.03	1.02
8	ADA	Cardano	34.44	5.80
9	SOL	Solana	197.21	9.98
10	MATIC	Polygon	268.00	9.13
11	DOT	Polkadot	13.73	9.17
12	DAI	Dai	1.05	3.74
13	TRX	TRON	9.00	2.60
14	AVAX	Avalanche	28.50	10.60
15	UNI1	Uniswap	25.55	8.44
16	WBTC	Wrapped Bitcoin	6.41	9.17
17	LEO	UNUS SED LEO	3.35	3.06
18	LTC	Litecoin	9.34	7.24
19	ETC	Ethereum Classic	37.64	5.15

20	LINK	Chainlink	6.24	7.12
21	ATOM	Cosmos	10.59	7.96
22	FTT	FTX Token	25.46	3.29
23	XLM	Stellar	11.43	4.40
24	CRO	Cronos	5.40	9.70
25	XMR	Monero	5.50	3.05
26	ALGO	Algorand	11.55	10.11
27	BCH	Bitcoin Cash	7.63	7.60
28	BTCB	Bitcoin BEP2	10.35	3.90
29	VET	VeChain	28.00	9.50
30	QNT	Quant	54.57	8.36
31	FIL	Filecoin	12.75	16.80
32	HBAR	Hedera	19.00	8.00
33	XTZ	Tezos	5.12	7.65
34	CHZ	Chiliz	89.00	8.00
35	EGLD	Elrond	46.20	14.13
36	MANA	Decentraland	27.17	9.37
37	SAND	The Sandbox	40.00	12.79
38	WBNB	Wrapped BNB	29.11	3.70
39	EOS	EOS	1.45	1.63
40	THETA	Theta Network	28.91	8.92
		AVERAGE	29.26	6.80

DATA SOURCE: Yahoo! Finance. NOTE: "Year 1" refers to the period from Q4 2020 to Q4 2021 and "Year 2" refers to the period from Q4 2021 to Q4 2022.

The average high/low ratio for Year 1 was 29.3, which indicates significant volatility in the market for cryptocurrency. As expected, the four stablecoin cryptocurrencies, Tether (USDT), USD Coin (USDC), Binance USD (BUSD), and DAI, demonstrated the least price volatility with high/low ratios ranging from 1.03 to 1.05 in Year 1. Otherwise, the most stable of the cryptocurrencies in Year 1 was EOS (EOS) with a high/low ratio of 1.45 followed by LEO at 3.35. The most volatile cryptocurrency was Polygon (MATIC) with a high/low ratio of 268 followed by Solano at 197.2. In Year 2, the average high/low ratio was 6.8, suggesting a stabilization of the crypto market. As in Year 1, USDT and BUSD had the lowest high/low ratios of 1.08 and 1.02, respectively. However, the other two stablecoins, USDC and DAI, experienced unusual variations in price with high/low ratios of 2.34 and 3.74, respectively. As expected from its 90% loss of value in Year 2, FIL had the largest high/low ratio at 16.8 followed by Elrond (EGLD) at 14.1 and SAND at 12.8. Once again, EOS was the most stable of the non-stablecoins with a high/low ratio of 1.08 followed by TRON (TRX) at 2.60.

We then calculated the high/low ratios for the four major indexes. Results appear in Table 5. The high/low ratios ranged from 1.36 for the DJIA to 1.58 for the Russell 2000 in Year 1 and from 1.29 for the DJIA to 1.53 for the Nasdaq in Year 2.

Table 5. Major market indices high/low ratios.

Ticker (-USD)	Market Index	Year 1 High/Low Ratio	Year 2 High/Low Ratio
DJI	Dow Jones Industrial Average	1.36	1.29
IXIC	NASDAQ Composite	1.4	1.53
GSPC	S&P 500	1.41	1.34
RUT	Russell 2000	1.58	1.50
	AVERAGE	1.44	1.42

DATA SOURCE: Yahoo! Finance. NOTE: "Year 1" refers to the period from Q4 2020 to Q4 2021 and "Year 2" refers to the period from Q4 2021 to Q4 2022.

The final step of our analysis of the financial performance of cryptocurrencies was to conduct one-sample t-tests to determine if the mean price changes and high/low ratios for cryptocurrencies were significantly different from the value and volatility of the major market indexes. Results appear in Table 6.

Table 6. *t*-Test results.

One-Sample *t*-Tests	Year 1 Change Crypto vs. Market Indices	Year 2 Change Crypto vs. Market Indices	Year 1 High/Low Ratio Crypto vs. Market Indices	Year 2 High/Low Ratio Crypto vs. Market Indices
Mean ($\bar{x}$)	903.4%	−46.4%	29.26	6.80
Standard deviation (s)	12.416	0.333	51.064	3.623
Count (n)	40	40	40	40
Standard error of mean (SEM)	1.9632	0.0527	8.0739	0.5729
Degrees of freedom (df)	39	39	39	39
Dow Jones Industrial (μ)	21.4%	−15.3%	1.36	1.29
t-statistic	4.492	4.680	3.907	3.946
p-value	<0.001	<0.001	<0.001	<0.001
Nasdaq (μ)	28.4%	−27.0%	1.42	1.53
t-statistic	4.457	4.739	3.876	3.820
p-value	<0.001	<0.001	<0.001	<0.001
S&P 500 (μ)	27.5%	−16.9%	1.41	1.34
t-statistic	4.461	4.688	3.885	3.917
p-value	<0.001	<0.001	<0.001	<0.001
Russell 2000 (μ)	46.2%	−24.5%	1.58	1.50
t-statistic	4.366	4.726	3.799	3.838
p-value	<0.001	<0.001	<0.001	<0.001

NOTE: "Year 1" refers to the period from Q4 2020 to Q4 2021 and "Year 2" refers to the period from Q4 2021 to Q4 2022.

In Year 1, the average percentage increase in price for the major cryptocurrencies was significantly greater than the average increase in the value of the DJIA ($t = 4.492$, $p < 0.001$), Nasdaq ($t = 4.457$, $p < 0.001$), S&P 500 ($t = 4.461$ $p < 0.001$), and Russell 2000 ($t = 4.366$, $p < 0.001$). In contrast, the average decrease in price for cryptocurrencies in Year 2 was significantly greater than the average loss in value of the DJIA ($t = 4.680$, $p < 0.001$), Nasdaq ($t = 4.739$, $p < 0.001$), S&P 500 ($t = 4.688$, $p < 0.001$), and Russell 2000 ($t = 4.726$, $p < 0.001$). Over the two-year period in this study, average cryptocurrency prices increased by nearly 400% compared to a loss of 6.3% in the Nasdaq and modest gains of 2.8%, 5.9%, and 10.3% by the DJIA, S&P 500, and Russell 2000, respectively. In short, over the two-year period, cryptocurrency offered investors greater opportunities for gain than investing in the stock market but with significantly greater risk. Year 2 of the study would have been a disaster for the average cryptocurrency investor, losing an average of 46.4%, when the DJIA lost about a third as much, 15.3%.

In Year 1, the average high/low ratio for cryptocurrencies was significantly greater than the high/low ratios for the DJIA ($t = 3.907$, $p < 0.001$), Nasdaq ($t = 3.876$, $p < 0.001$), S&P 500 ($t = 3.885$, $p < 0.001$), and Russell 2000 ($t = 3.799$, $p < 0.001$). While the volatility in cryptocurrencies was considerably lower in Year 2, it was still significantly higher than DJIA ($t = 3.946$, $p < 0.001$), Nasdaq ($t = 3.820$, $p < 0.001$), S&P 500 ($t = 3.917$, $p < 0.001$), and Russell 2000 ($t = 3.838$, $p < 0.001$). Over the two-year period represented in this study, cryptocurrencies had an average high/low ratio of 42.5, which was significantly higher than the high/low ratios for the four major indexes.

5. Conclusions

This study described the major cryptocurrencies, presented notable fraud cases, identified fraud risks, and analyzed cryptocurrency financial performance. There has been an intense debate over the real value of cryptocurrency. In some past years, cryptocurrency investments have yielded large returns for many investors, but past financial performance does not guarantee future performance. This is especially true if critics are right, and cryptocurrency is simply a new form of the Dutch Tulip Bubble that will eventually leave investors with nothing. Even worse, some have called the cryptocurrency industry a giant Ponzi scheme, a fraud perpetrated by industry leaders, accompanied by endorsements from high-profile celebrities.

Regarding financial performance, two recent years of financial performance by major cryptocurrencies were presented. High returns were followed by dismal financial performance. In addition, several major fraud cases were described. The financial scandals, particularly, the FTX collapse and bankruptcy, have led government leaders to consider new regulations to provide oversight to the industry. What effect this might have on future cryptocurrency financial performance is unknown.

Investments in cryptocurrencies and investments in publicly traded companies are alike in that prices may rapidly rise or fall based on wild speculation. Volatility, though, is much higher for cryptocurrencies, thereby increasing risks enormously. Cryptocurrency versus stock investments are very different, in that the real or intrinsic value of cryptocurrencies is essentially zero, while corporate stock value is ultimately determined by actual corporate profits or lack thereof, as disclosed in the audited financial statements. Understanding the positive and negative aspects of cryptocurrency is important to investors, regulators, and academic researchers regarding the cryptocurrency industry.

6. Limitations and Future Research

This study is limited by the cryptocurrencies examined and by the time period used. Future studies could examine other cryptocurrencies and other time periods. This study was limited by the prior research cited in the paper. Future studies could expand the literature review and include additional past research. This study was limited to American stock indices; other indices could be used in future studies. The study is limited by data sources, such as Yahoo! Finance. Future studies might consider using other sources.

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