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Market efficiency, volatility dynamics and hedging effectiveness of digital assets: A systematic literature review.

Mr. P Baskar [1*], Ms. Bhumika Bunkar [2], Dr. R Kasilingam [3]

[1]Research Scholar, Department of Management Studies, Pondicherry University, Puducherry – 605014. Email: baskarppsamy25@gmail.com,
[2]Research Scholar, Department of Management Studies, Pondicherry University, Puducherry – 605014. Email: bhumika.bunkar04@gmail.com,
[3]Professor, Department of Management Studies, Pondicherry University, Puducherry – 605014. Email: kasilingam.dms@gmail.com

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Abstract

Digital assets are store of value that emerged as the prominent application of blockchain technology. Some digital asset variants are cryptocurrency, Non-Fungible Tokens, Decentralized Finance, and Stablecoin. Digital assets' value and popularity surged in the last decade, attracting investors while possessing challenges for regulators and policymakers. In light of the above circumstances, the study aims to uncover the most researched themes and critically review the prominent research themes in digital assets literature that are limited to the subject area of Economics, Econometrics, and Finance published in peer-reviewed journals collected from the SCOPUS indexed journals during the timeframe 2009 to 2024 with the help of bibliometric analysis performed in VOS viewer software. Conclusively the study provides important insights that lead to the evolution of digital assets literature and identifies the most productive authors and sources. Content analysis highlights the most frequently used keywords such as market efficiency, asset pricing, volatility dynamics, and hedging effectiveness with the variants of digital assets. Finally, the study discusses the possible future research direction of digital assets literature.

Keywords: Digital Assets, Cryptocurrency, Non-Fungible Tokens, Decentralized Finance, Literature Review.

1. Introduction

The concept of decentralized digital currency came into the limelight with the advent of Bitcoin which disrupted the traditional financial market by allowing direct payment between sender and receiver with the help of a hash-based proof of mechanism (Nakamoto, 2008). Bitcoin is an advancement from the previous decentralized cash system proposed by the authors (Chaum, 1983; Okamoto, 1995; Back, 2002; Camenisch et al., 2005; Canard & Gouget, 2007). However, Bitcoin overcomes the earlier decentralized cash system by addressing the double spending problem by creating a set of nodes that can authenticate the transactions of peer nodes (Dwyer, 2015). Bitcoin turned out to be a financial asset from a payment settlement tool and opened up a new kind of asset termed cryptocurrency.

The immense popularity of cryptocurrency can be ascribed to their distinct attributes, such as their decentralized system, low transaction cost, and being disconnected from national economies or any other underlying assets. These attributes have drawn the interest of global financial institutions, investors, and media outlets (Brandvold et al., 2015; Corbet et al., 2019; Li et al., 2021). According to coinmarketcap.com, more than 9000 cryptocurrencies are in active circulation with a market value of $2.25T in specific Bitcoin alone shares 56.88% of the total value which is $1.28T followed by Ethereum with $306B which shares 13.6% of the total value as of 14th Oct 2024. The Market capitalization of other types of digital assets such as Non-Fungible Tokens (NFT) and Decentralized Finance (DeFi) stood at $22.84B and $88.25B respectively as of 14th Oct 2024. NFTs are applications of smart contract features of Ethereum that help to identify unique digital content such as video, images, and art thus NFTs enable the creator of digital content to earn royalties while trading and preserving intellectual property(Q. Wang et al., 2021).

Since digital assets are an emerging area in finance it is important to review and compile existing literature into different research streams. The same has been accomplished by Almeida & Gonçalves, (2022) reviewed volatility and risk management of cryptocurrency and intend to explore a methodology to predict volatility. Ballis & Verousis, (2022) review important factor that drives cryptocurrency prices such as public sentiments and investor behavior. Similarly Almeida & Gonçalves, (2023) review the article that studied hedging, safe-haven, and diversification capabilities of digital assets for various markets. Kyriazis, (2019) reviews the efficient market hypothesis, long memory features, and pricing predictability of cryptocurrencies. Bao & Roubaud, (2022) reviews asset pricing, risk, and regulation of NFTs. The previous study reviewed primarily cryptocurrency alone it is essential to include other types of digital assets like DeFi, NFTs, and Stablecoins. To address the gap, the study includes all types of assets defined under digital assets. It aims to identify the most researched terms with the help of bibliometrics analysis and to critically review the identified research streams.

Finally, the study extends the contribution to the previous study by identifying the exponential growth in digital assets literature and highlighting the most contributing sources, authors, their respective affiliation, and their countries. Critically reviewing the articles that have exclusively studied market efficiency, volatility dynamics, and hedging effectiveness. The remaining sections are organized as follows Section 2 presents the methodological part, Section 3 conducts bibliometrics analysis, and Sections 4-6 reviews the literature findings on market efficiency, volatility dynamics, and hedging effectiveness respectively. Section 7 concludes with future research avenues and limitations.

2. Methodology

The study adopts a systematic review process supported by bibliometric analysis (van Eck & Waltman, 2010). The bibliometric data are collected from the Scopus database which comprises renowned journals, conference proceedings, and books from eminent publishers like Elsevier, Wiley, Emerald, Springer, and Nature (Abbas et al., 2024; Bretas & Alon, 2021). The study aims to identify various research themes, critically review the literature, and discuss possible future research avenues. Broader keywords are considered with search query ("Digital Assets" OR "Blockchain Markets" OR "Cryptocurrenc*" OR "Bitcoin" OR "Non-Fungible Tokens" OR "NFTs" OR "Nonfungible Tokens" OR "Decentralized Finance"). The year 2009 is considered the base year for digital assets literature because the article “Bitcoin: A Peer to Peer Electronic Cash System” published in the year 2008 acts as a base for digital assets literature. For an in-depth review, the study looks at the literature on Economics, Econometrics, and Finance, as well as the articles published in peer-reviewed journals in the English language. After the inclusion and exclusion process, 3880 articles were kept for analysis as shown in Table 1. Following the study by (Almeida & Gonçalves, 2023), (Gairola & Dey, 2023), (Nesari et al., 2022) (Fernández et al., 2023) VOS viewer is adopted for the identification of clusters with the help of keyword co-occurrence analysis, the keywords are connected when both keywords are mentioned in a particular article thus a group of connected keywords forms a cluster.

Table. 1 Inclusion and Exclusion Criteria

Step	Description	Total articles
Step 1	Article retrieved from Scopus database with selected keywords	26,336
Step 2	Articles related to subject areas: Economics, Econometrics, and Finance	5,354
Step 3	Articles published in peer-reviewed journals	3,977
Step 4	Articles pertain to the English language	3,881
Step 5	Articles limiting to the year 2009 to 2024	3,880

3. Bibliometric Analysis

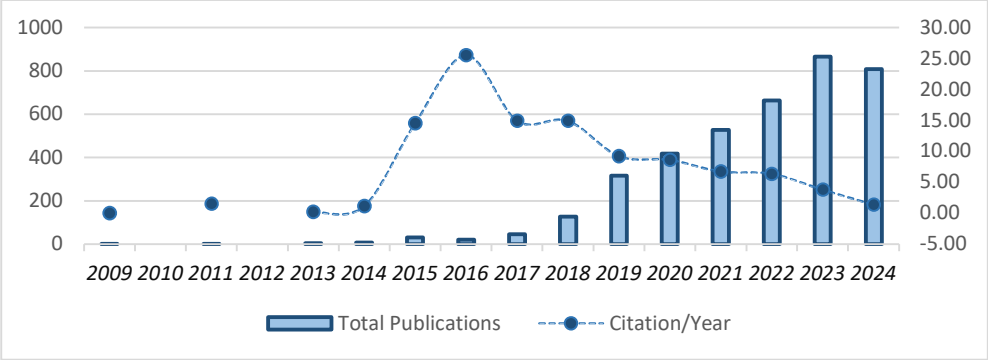
Bibliometric analysis helps map scientific publications and divulge the insights of the large volume of scientific publications in a specific field(Zupic & Čater, 2015). An in-depth bibliometric analysis can open up new avenues for the inventive investigation of knowledge gaps (Donthu et al., 2021).

3.1. Literature trends

The first of our analysis addresses publication trends and citation count of digital assets literature for the period 2009 to 2024. It is seen in Fig.1 that the average number of citations peaked in 2016 at 25.53 citations per year and the literature grew at an exponential rate after the year 2014 this is due to the invention of alternative cryptocurrencies especially Ethereum with smart contract features that paved the way for multiple applications that attract the interest of researcher and academicians around the globe (Buterin, 2014). Initial research of digital assets is primarily on the design principle (Böhme et al., 2015) and subsequent studies that explored the financial assets features of Bitcoin and compared

it with gold for diversification capabilities (Dyhrberg, 2016a). further digital assets literature are built upon the above literature.

Figure. 1 Literature trends



3.2. Source

Source disseminates research results in a specific area contributes significantly to the advancement of knowledge and acts as a platform for the scientific community. Table 2 lists major sources that have contributed to digital assets literature in terms of publications and citations. The Source Finance Research Letters made a significant contribution to the topic, in terms of publication and impact.

Table 2. Source

Rank	Journal	Number of Publications	Total Citation	Citation per publication
1	Finance Research Letters	426	21237	49.85
2	Research in International Business and Finance	159	5246	32.99
3	Journal of Risk and Financial Management	147	1843	12.53
4	International Review of Financial Analysis	129	7341	56.90
5	Financial Innovation	114	2186	19.17

3.3. Authors

Around 6323 authors contributed novel insights of knowledge in digital asset literature. The most influential authors ranked by the number of publications and citations are shown in the table.3 Interestingly Dr. Bouri E, affiliated with Lebanese American University, Lebanon is in the apex place. Followed by Dr. Corbet S affiliated with Dublin City University, Ireland. And Dr. Roubaud D affiliated with the University of Southampton, UK has contributed much to digital assets literature.

Table 3 Influential authors

Rank	Authors	NP	TC	H_index
1	Bouri E	77	8003	40
2	Corbet S	54	5560	33
3	Roubaud D	32	6189	29
4	Yarovaya L	35	3751	24
5	Lucey B	29	5148	22

3.4. Keyword Co-occurrence analysis

Keywords encapsulate the underlying theme of the research article and represent the content of the article. Keywords help in highlighting key topics addressed in the research. Figure. 2 reveals the most researched terms in the digital asset literature are studies on volatility, market efficiency, hedging, safe-haven, and portfolio diversification capabilities of different digital assets like Bitcoin, cryptocurrency, NFTs, and DeFi.

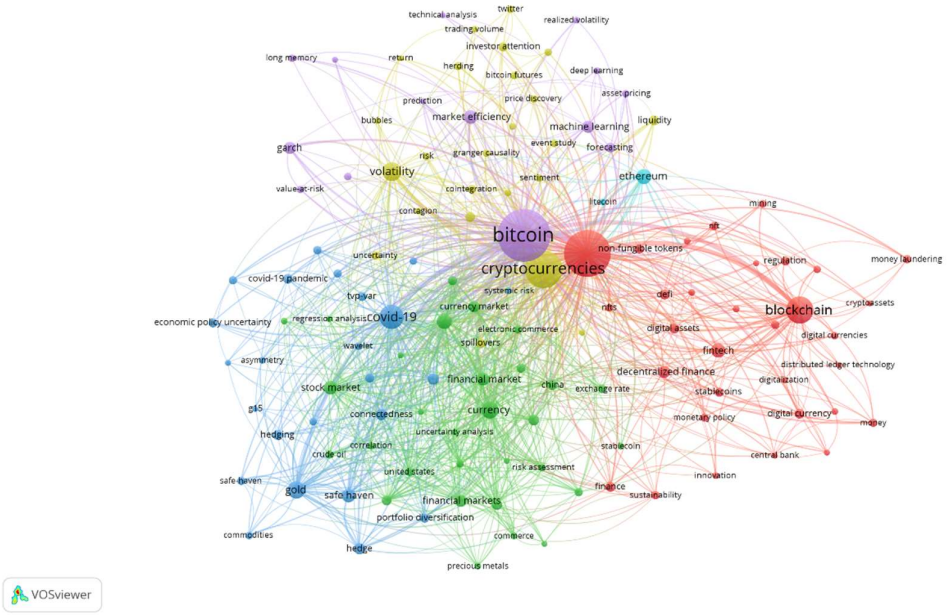


Fig. 2. Keyword Coocurrance analysis

4. Literature findings on Market efficiency

4.1. Market efficiency of Bitcoin

The Efficient Market Hypothesis (EMH) is prominent in the area of finance proposed by Fama, (1970). However, empirical work started with the work of Bachelier, (1900) introduced randomness and uncertainty in financial markets. A market is efficient if the asset price reflects all available information about the market and further differentiates the market as weak, semi-strong, and strong. The weak form of EMH has been studied for traditional assets stocks, bonds, and commodities. However Urquhart, (2016) was the first to investigate weak forms of Bitcoin using various tests. The results of the above test suggest that Bitcoin is inefficient across the sample period; however, when the sample is divided into two subsamples efficiency improves in the latter period. In line with the above findings results of the portmanteau test and martingale difference hypothesis suggest Bitcoin are largely inefficient (Nadarajah & Chu, 2017). Similarly, the results of the rolling window approach, Hurst Detrended Fluctuation Analysis (DFA), and similar analyses confirm long memory features in Bitcoin and further argue inefficiency is due to the irrational behaviour of investors and inappropriate pricing mechanism (Bariviera, 2017; Tiwari et al., 2018) .

4.2. Market efficiency using liquidity

Apart from asset return and price the literature that examines market efficiency using liquidity of the asset is studied in this section. The role of trade volume in predicting Bitcoin return using the causality-in-quantile approach reveals that the traded volume of Bitcoin can predict its return in the middle quantile but not in lower and upper quantiles (Balcilar et al., 2017). Similarly, the Amihud ratio is used to classify 456 cryptocurrencies based on liquidity suggesting that high-liquidity cryptocurrencies have strong efficiency relative to other illiquid cryptocurrencies (Wei, 2018). The rolling window approach utilized on five major cryptocurrencies suggests initially cryptocurrency has been inefficient. However, the efficiency of cryptocurrency improves with an increase in volume (Tran & Leirvik, 2020; Al-Yahyaee et al., 2020). NFTs show consistent with cryptocurrency as significant dependence between trade volume and return (Urom et al., 2022).Thus liquidity and market capitalization positively drive efficiency, while Bid and Ask spread negatively drive efficiency (Brauneis & Mestel, 2018).

5. Literature findings on volatility dynamics

5.1. Volatility dynamics of Bitcoin

Bitcoin was initially intended as a medium of exchange but later turned into a speculative asset and exhibits high volatility compared to traditional assets influenced by market participants rather than major economic factors (Baek &

Elbeck, 2015). This led to exploring the role of Bitcoin as a financial asset and comparing it with gold and USD for risk management and portfolio analysis and placing it between commodity and currency (Dyhrberg, 2016a; Baur et al., 2017). Bitcoin exhibits time-varying spillover on traditional assets irrespective of bull and bear market conditions and is more weakly correlated with green assets (Bouri et al., 2018; Duan et al., (2023). And identified AR-CGARCH as an appropriate model to describe Bitcoin price volatility (Katsiampa, 2017).

5.2. Volatility spillover of Bitcoin to another cryptocurrency

Bitcoin's value surged with an increase in several alternative cryptocurrencies. Yi et al., (2018) investigated the dominance of Bitcoin in transmitting volatility shocks to new alternative cryptocurrencies. Bitcoin has limited influence on other cryptocurrencies and volatility shock transmission depends neither on market capitalization nor price but depends on cryptocurrency features, supply, and demand (Ciaian et al., 2018). Structural breaks spread from cryptocurrency with smaller capitalization to larger capitalization and all cryptocurrencies possess a strong correlation in volatility spillover (Canh et al., 2019). In contrast to previous findings, volatility shock transmission among 18 cryptocurrencies shows Bitcoin as dominant (Koutmos, 2018).

5.3 Digital assets volatility spillover on traditional assets

The interconnectedness between cryptocurrencies such as Bitcoin, Ripple, and Litecoin with US stock indices was examined during extreme economic conditions suggesting cryptocurrencies are highly connected among them while disconnected from equity (Corbet et al., 2018; Aslanidis et al., 2019).Volatility between cryptocurrency and commodity markets is tested with various GARCH models suggesting GO-GARCH (2,2) is the best-fit model for connectedness between assets and suggesting that Bitcoin and Ethereum are positively correlated with each other but exhibit a negative correlation with gold and natural gas (Bouazizi et al., 2023). Consequently, the volatility spillover of digital assets with emerging and developed market indices is examined using the SNP-DCC model reveals the transmission effect between these markets indicates market integration (Jiménez et al., 2023).

5.4. Digital asset connectedness with the energy market and green assets

The rising energy consumption of Bitcoin leads to underpin interconnection between energy and carbon markets (Long et al., 2023). Even though the price of cryptocurrency is heavily influenced by energy, the relationship between cryptocurrency and energy commodities is weak, time-varying, and event-dependent (Ji, Bouri, Roubaud, et al., 2019; Tiwari et al., 2024). Cryptocurrency exhibits bi-directional asymmetric volatility spillover to clean energy and fossil fuel (Symitsi & Chalvatzis, 2018; and Okorie & Lin, 2020). The volatility transmission between cryptocurrencies and energy markets is examined during times of uncertainty like COVID-19, and uncertainty indexes like Economic Policy Uncertainty (EPU) and Twitter Based Uncertainty (TWU) analyzed with DECO- GARCH model suggests volatility connectedness intensifies with uncertainty (Wan et al., 2023). A Proof of Stake-based cryptocurrency termed clean cryptocurrency requires less power which reduces negative ramifications to the environment. The clean cryptocurrency provides diversification potential for renewable energy markets at downside risk (Naeem et al., 2023). The clean cryptocurrency is connected to green stock indices of the US, Europe, and Asia and the proof of work-based dirty cryptocurrencies are more connected to carbon markets than clean cryptocurrencies (Pham et al., 2022).

6. Literature findings on Hedging, safe-haven, and Diversification.

Digital assets are a new class of assets with unique characteristics such as independence from monetary policy, the ability to act as a store of value, and lack of correlation with traditional assets offering hedging, safe-haven, and diversification opportunities to traditional assets. This demands an empirical test of the hedging, safe haven, and diversification properties (Conlon & McGee, 2020). The modern portfolio theory put forth by Markowitz recommends asset diversification as a way to protect against both market risk and asset-specific risk. It is necessary to differentiate hedging, safe-haven, and diversification, if the assets are uncorrelated or negatively correlated then termed as weak hedge or strong hedge respectively. Similarly, during distress time if the assets are uncorrelated or negatively correlated then weak safe-haven or strong safe-haven respectively. The term diversifier is defined when assets are positively but not perfectively correlated with other assets (Bouri et al., 2017).

6.1. Is Bitcoin a better hedge than Gold?

Early research on digital assets compared Bitcoin’s hedging capabilities with gold for conventional assets. Bitcoin and

gold exhibit similar hedging properties against traditional assets and reduce down-tail risk (Selmi et al., 2018). At the same time, Bitcoin together with gold in a portfolio can provide a hedge against US stock indices (Dyhrberg, 2016b). When Bitcoin is incorporated into a portfolio, offers far superior hedging than a portfolio of stocks, gold, and oil (Guesmi et al., 2019). Both gold and Bitcoin have hedging qualities for the G7 stock market, but gold is a better hedge (Hussain Shahzad et al., 2020). Gold and Bitcoin exhibit a time-varying diversification potential and weak safe haven against the lowest tail of major stock indices (Shahzad et al., 2019; Bouri, Shahzad, et al., 2020). Gold exhibits a consistent safe haven for various stock indices while Bitcoin shows mixed results (Kumar & Padakandla, 2022). Gold serves as a safe haven during a downturn in the equity market, while Bitcoin intensifies its downward movement (Klein et al., 2018).

6.2. Safe-haven properties of digital assets during market turmoil

Volatility in the market causes asset prices to fluctuate greatly and undermines the stability of the financial system. The COVID-19 pandemic in recent years has led to an unparalleled decline in commodity prices. For example, Brent oil dropped from $52.52 per barrel in March 2020 to $9.12 per barrel in April 2020. Similarly, WTI crude oil fell to a record low of $36.98 per barrel in April 2020 from $46.78 per barrel in March 2020 (Gharib et al., 2021). According to Statista Euro-American and Asian markets have lost 40% and 25% of value in March 2020 compared to January 2020 respectively. In these sections, the literature that examined the safe haven properties of digital assets during COVID-19 are presented. When the safe haven properties of Bitcoin and gold are compared against major stock indexes, Bitcoin cannot be regarded as a safe haven while gold is a weak safe haven (Chemkha et al., 2021). Similarly, Ethereum with Bitcoin intensifies risk for major stock markets rather than providing a safe haven (Maitra et al., 2022; Corbet, Larkin, et al., 2020; Conlon & McGee, 2020; and Dwita Mariana et al., 2021). Stablecoin backed up underlying assets posses consistent safe haven to global stock indices especially USD pegged stablecoin safe haven ability exceeds gold and Bitcoin (Conlon et al., 2020; J. Feng et al., 2024; and Goodell & Goutte, 2021). Gold acts as a safe haven, while Bitcoin is a diversifier for commodities like Oil during COVID-19 (Dutta et al., 2020). The safe haven potential of eight major cryptocurrencies is examined against the downturn of US equities suggesting heterogeneity in safe-haven capabilities while Bitcoin, Ripple, and Stellar provide better diversification (Bouri et al., 2020). As a whole cryptocurrency acts as an attractive investment during the pandemic as price and transaction volume remain stable (Lahmiri, 2024).

6.3. Better diversification among digital assets

The literature that examines the diversification potential of various digital assets and tries to identify better diversifiers among digital assets is consolidated as follows. The role of cryptocurrency as a better hedge, safe haven and diversification examined with six major cryptocurrencies against six stock market indices using a quantile coherency approach suggests cryptocurrency is neither a strong hedge nor a safe haven but possesses stronger diversification potential at a lower quantile (Jiang, Lie, et al., 2021). Similarly, the cross-correlation between cryptocurrency and traditional assets is time-varying and exhibits diversification potential but not as a hedge (Charfeddine et al., 2020). Cryptocurrency's extreme characteristics are evaluated with a tail correlation against major stock indices suggesting cryptocurrency possesses greater diversification potential than hedge or safe-haven (W. Feng et al., 2018). During the cryptocurrency market downturn, NFTs act as short to medium-term diversifiers specifically for Bitcoin and Ethereum (Kumar & Padakandla, 2023). NFTs and DeFi offer potential diversification benefits for Bitcoin, Gold, Bond Oil, and Stock markets (Yousaf & Yarovaya, 2022; Umar et al., 2022; and Ko et al., 2022). In specific NFTs provide relatively better diversification compared with cryptocurrency and DeFi (Karim et al., 2022). An asset-backed stablecoin acts as an effective diversifier and is better than its underlying assets particularly USD-pegged stablecoin provides better diversification than a gold-pegged stablecoin (Wang et al., 2020).

7. Conclusion

In this study, Bibliometric analysis is utilized to identify major researched terms in the digital assets literature collected from the Scopus database from the year 2009 to 2014. Critically reviewed the identified research areas such as market efficiency, volatility dynamics, hedging, safe-haven, and diversification capabilities. From bibliometric analysis, it is inferred that literature has grown at an exponential rate from the year 2014 and continues to grow. The primary reason for the breakthrough is the advent of Ethereum a smart contract-based cryptocurrency in 2014 which provides various decentralized applications. The journal Finance Research Letters stands out as the most impactful in terms of citations and publications. The study highlights Dr. Bouri E, and Dr. Corbet S as the most productive authors affiliated with Lebanese American University, Lebanon, and Dublin City University, Ireland respectively.

The initial literature of digital assets is mostly on Bitcoin after critically reviewing literature that examines the market

efficiency of Bitcoin it is identified that Bitcoin is inefficient and shows sign efficiency in the later stage. Cryptocurrency as a whole exhibits inefficiency in the short term and efficient increase in the long term and trading volume of cryptocurrency positively affects efficiency. The analysis of volatility spillover among cryptocurrencies reveals that they are interrelated and that the existence of bi-directional spillover in particular spillovers depends on the attributes of the cryptocurrency rather than its market size. While examining volatility spillover of digital assets with traditional assets are reveals digital assets are disconnected from traditional assets opening the possibility of hedging, safe-haven, and diversification capabilities. Bitcoin compared with gold for hedging capabilities for various stock market indices, commodities, and currencies reveals gold acts as a better hedge. In comparison, Bitcoin provides a time-varying hedge. During market downturns like Covid-19 digital assets intensify downturn rather than safe-haven and act as potential diversifiers.

As the study is limited to the Scopus database for the literature there may be the possibility of missing out on influential articles. This study contributes to researchers, investors, regulators, and academicians with a compilation of empirical results that helps to devise investment strategies and pay the way for further research with new kinds of digital assets like NFTs, DeFi, and stablecoins interaction with cryptocurrencies and traditional assets can be investigated for portfolio management.

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