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Complex and Multifaceted Nature of Cryptocurrency Markets: A Study to Understand its Time-Varying Volatility Dynamics

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Abstract

Decentralised Finance (DeFi) provides a new way to perform complex financial transactions by exploiting blockchain's ability to maintain a decentralised ledger of transactions without being constrained by centralised systems or human intermediaries. DeFi provides alternative financial instruments that might lessen portfolio risk, especially given the erratic state of the financial markets today. This study analyses the association between the year of the coin in which it was introduced and the market capitalisation of the respective companies. Furthermore, the study also tries to understand the volatility associated with cryptocurrencies using EGARCH & GJR-GARCH models. The results reveal that market capitalisation is not similar for all three stages of the age of cryptocurrency. Also, negative news tends to impact Bitcoin more than positive news, and the volatility is persistent and long-lasting. Ethereum, BNB & Solana see more volatility from absolute past shocks; however, Tether exhibits low but persistent volatility as a stablecoin.

Keywords: *Decentralised Finance, DeFi, Cryptocurrency, Market Capitalization, EGARCH, GJR-GARCH*

Introduction

Decentralised Finance (DeFi) intends to revolutionise Finance by replacing traditional, centralised institutions with peer-to-peer connections capable of providing a wide range of financial services, including ordinary banking, loans, and mortgages, as well as complex contractual interactions and asset trading(Metelski & Sobieraj, 2022). In India, the Reserve Bank of India (RBI) regulates the business of 'centralised financial institutions' and trading firms(Bajaj, 2022). Therefore, consumers have few opportunities to obtain finance and related services. They cannot skip intermediaries such as banks, exchangers, and lenders, who profit from every financial and banking transaction. Everyone has to pay in order to participate. The primary objective of Decentralised Finance is to create a financial system that runs entirely on code, without the need for conventional middlemen (Meyer et al., 2022). It challenges the centralised financial system by removing intermediaries and gatekeepers and authorising ordinary people through peer-to-peer trades(Salami, 2020).

Decentralised Finance has become an influential player in the financial services sector, using blockchain technology to displace established financial institutions (Puschmann & Huang-Sui, 2024). In fact, blockchain technology forms the fundamental basis of contemporary digital currency systems and has applications far beyond cryptocurrencies. All network users can see transactions that are registered on the blockchain. Accountability is ensured, and fraud is prevented because of this transparency. Each transaction is encrypted and authenticated using cryptographic techniques before being added to the blockchain, ensuring security (Beinke et al., 2024). Create a clear taxonomy to assist regulators, specialists, and decision-makers(Alamsyah et al., 2024).

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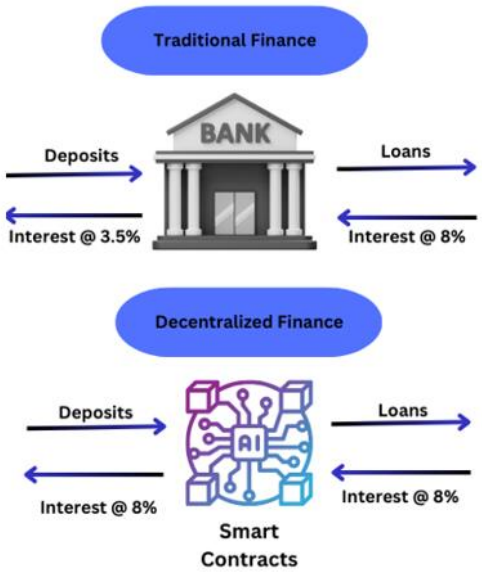

Figure 1. Example: Traditional Vs Decentralized Finance

Source: Author's Compilation

"Decentralised finance is the unbundling of traditional finance," explains Rafael Cosman, TrustToken's CEO and co-founder. "DeFi takes the key elements of the work done by banks, exchanges and insurers today—like lending, borrowing and trading—and puts it in the hands of regular people." Today, as shown in Figure 1, one can keep money in an online savings account and receive 3.50% interest. The bank then lends the money to another customer for 8% interest, pocketing the 4.5% profit. With DeFi, consumers lend their funds directly to others, avoiding the 4.5% profit/loss and earning the full 8% interest on their money (Napoletano, 2024).

Technologies Backing Decentralised Finance

Blockchain systems like Ethereum, Binance Smart Chain, and others are used to build most DeFi projects. These blockchains offer the infrastructure for smart contracts and decentralised applications (dApps), which are necessary for carrying out financial transactions without the need for intermediaries. Self-executing contracts, or smart contracts, have the conditions of the contract explicitly encoded into the code. They enable trustless transactions by automatically enforcing the contract rules when predefined criteria are met.

Smart contracts play a significant role in DeFi platforms' ability to perform various tasks like lending, borrowing, trading, and more. Smart contracts are self-executing programs that contain pre-written, coded rules and conditions. They run on blockchain systems, like Ethereum, and take automatic action when certain thresholds are reached (John et al., 2023). DEXs make peer-to-peer trading of digital assets possible, eliminating the need for intermediaries. They ensure that transactions are carried out securely and transparently by using smart contracts to automate trade procedures.

Oracles serve as a link between real-world data and smart contracts built on the blockchain. They give decentralised apps access to external data, such as price feeds. Oracles, like decentralised lending platforms, are essential to DeFi protocols, which depend on fast and reliable data to carry out transactions.

Stablecoins are virtual currencies that tie their value to a reliable asset, such as fiat money (like the USD), to reduce price volatility. Because they offer a dependable store of value and means of exchange for use in

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decentralised financial applications, stablecoins are essential to DeFi. Layer 2 scaling solutions may be used by DeFi projects to overcome scalability issues and excessive transaction fees on specific blockchains. By processing transactions off-chain or through extra layers, these solutions seek to lower costs while increasing transaction throughput and maintaining the security of the underlying blockchain. In order to validate user identities independently of centralised authority, certain DeFi projects use decentralised identity systems. Thanks to decentralised identity technologies, users can securely interact with financial services and keep control over their personal information.

Together, these technologies provide a decentralised financial ecosystem with a range of services that centralised financial institutions often offer but with more accessibility, transparency, and independence.

Decentralised Finance keeps growing by utilising the capabilities of decentralised applications (dapps) and protocols to penetrate a range of traditional and intricate financial activities. Transactions are mostly made possible by these dapps and protocols using Ethereum (ETH) and Bitcoin (BTC), the two most popular cryptocurrencies. Although Bitcoin is still the most popular cryptocurrency, Ethereum is a favoured platform for various applications due to its versatility. As a result, Ethereum technology underpins a large portion of the dapp and protocol environment.
When DeFi apps are used in tandem with a blockchain, users may carry out various financial tasks without the assistance of intermediaries, including buying things, borrowing money, giving presents, selling assets, and more (Metelski & Sobieraj, 2022). These are simply installed programs that improve the usefulness of gadgets such as smartphones, tablets, and PCs. Cryptocurrencies may still function without these apps, but users must be proficient in utilising the operating system of their device's terminal or command line to communicate directly with the blockchain. DeFi applications provide a system that automates transactions between users by offering them a variety of financial prospects (Aspembitova & Bentley, 2022). For example, if one wants to extend a loan to someone and charge them interest, one can use the interface to add parameters such as interest or collateral. If a loan is needed, one can look for suppliers ranging from a bank to someone who will lend cryptocurrency once the terms are agreed upon.

Dapps and protocols are used in the following ways:

Traditional Financial Transactions: DeFi is already used for payments, trading stocks and insurance, lending, and borrowing.

Decentralised Exchanges (Dexes): Currently, most cryptocurrency investors use centralised exchanges such as Coinbase. DEXs enable peer-to-peer financial transactions while giving users ownership over their money. DeFi (Decentralised Finance) is transforming conventional financial transactions by enabling lending, borrowing, stock trading, insurance, and payments by eliminating intermediaries.

Important Elements of Defi Consist Of

Conventional Financial Transactions: DeFi provides an alternative to conventional financial systems and is currently used for payments, stock trading, insurance, lending, and borrowing.
Decentralised Exchanges (DEXes): DEXes provide consumers complete control over their money and enable peer-to-peer transactions, unlike controlled exchanges like Coinbase.
E-wallets: DeFi developers are building digital wallets that function apart from the main cryptocurrency exchanges, giving users access to various resources, such as blockchain-based games and cryptocurrencies.

StableCoins: By linking their value to non-crypto assets like the US dollar, these cryptocurrencies hope to lessen volatility.

Yield Harvesting: If the value of the tokens investors receive increases in response to interest, DeFi enables them to lend cryptocurrency and possibly make substantial profits.
Non-Fungible Tokens (NFTs): NFTs create new opportunities for asset commodification by converting non-tradable goods into tradeable digital assets, such as sports highlights or digital artwork. Short-term

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loans, also known as flash loans, are made possible by smart contracts running on the Ethereum blockchain (Teng et al., 2022). If a transaction fails, the funds are promptly returned to the borrower.

Peer-to-Peer (P2P) Financial Transactions: DeFi facilitates direct transactions between people, eliminating the need for intermediaries. These contracts are self-executing since their terms are encoded directly into the code. They eliminate the need for intermediaries by automatically enforcing and carrying out transactions once they are put on the blockchain. Once authenticated, transactions and smart contracts stored on a blockchain are unchangeable or immutable(Harvey & Rabetti, 2024). This guarantees an irreversible and unchangeable record. Every transaction and smart contract on the blockchain is open for anybody to inspect publicly. This degree of openness contributes to the system's development of accountability and confidence. Individual privacy is protected while user names remain pseudonymous, even though transaction details are transparent(Cloots, 2023). The decentralised nature of DeFi protocols reduces the necessity.

Literature Review

Since the launch of Bitcoin in 2009, cryptocurrencies (digital currencies that rely on cryptography for security) have completely changed the financial landscape. Over the last ten years, the cryptocurrency market has experienced exponential growth. The tremendous volatility of cryptocurrency markets is one of their distinguishing characteristics.

A thorough analysis of relevant academic literature was performed to deeply understand volatility in the decentralised finance domain and various digital currencies. Using a well-crafted search phrase, an extensive search in academic databases, including Scopus and Google Scholar, was conducted to find significant scholarly literature about the volatility modelling related to DeFi and cryptocurrencies.

Results of the study by Peng et al. (2018) imply that adding Support Vector Regression to the GARCH framework greatly improves volatility forecasting performance. This hybrid method increases accuracy while offering insightful advice on risk management and investing techniques for both traditional currency markets and cryptocurrency markets (Peng et al., 2018). The analysis concludes that while Bitcoin, Ethereum, and Ripple control most of the cryptocurrency market, other virtual currencies do not provide viable options for hedging against market downturns. This emphasises how intertwined the bitcoin market is and how difficult it is for investors to diversify their portfolios and manage risk (N. A. Kyriazis et al., 2019).

The anticipated benefits vary from a significant reduction in intermediary fees and transaction costs to the return of investor control and the change of today's restricted asset allocation techniques. Because the technical and regulatory constraints of increased automation and integration in the delivery of investment services will be significant, a proactive approach is essential to address these issues (Avgouleas & Kiayias, 2020).

The recent proliferation of COVID-19, stressed economies and government intervention in the market have reignited debate over the necessity for decentralised economies, the role of regulatory agencies, and whether Bitcoin is a legitimate store of value (M. Kumar et al., 2020).

Decentralised Finance remains one of the most popular areas of the cryptocurrency ecosystem, with blockchains such as Ethereum and Solana developing massively popular decentralised exchanges, staking opportunities, and liquidity pools at an alarming rate. The author presents a clear framework for the emerging peer-to-peer finance business, covering everything from decentralised borrowing and lending to the role of automated market makers and aggregators, as well as some of the industry's most significant benefits (and concerns) (Arslanian, 2022).

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Another investigation has identified bidirectional shock transmission effects between cryptocurrency pairs. This research emphasises how interdependent and interrelated the cryptocurrency market is and how shocks to one coin can greatly affect others. The multivariate Dynamic Conditional Correlation (DCC-GARCH) model was used to describe these dynamics of cross-market volatility. With this method, it was possible to successfully detect and simulate volatility shocks and how they spread among various cryptocurrency pairs (Ampountolas, 2022).

It emphasises how more sophisticated GARCH models can accurately represent the volatility swings in cryptocurrency markets. The study examines the salient features and best practices for estimating returns and volatility in cryptocurrencies, focusing on efficiency, herding behaviour, profit-risk measurement, hedging/diversification capabilities, and interconnectivity. It has been discovered that adding Bitcoin to portfolios with conventional assets could significantly improve investors' risk-return trade-off (N. A. Kyriazis, 2021).

Decentralised Finance (DeFi) is a relatively new concept in banking and Finance that is based on peer-to-peer payments enabled by blockchain technology. Blockchain technology enables DeFi to provide financial services without relying on traditional financial intermediaries such as banks or brokers. It is a new technology that has a huge impact on current society because of its distinct properties of security, decentralisation, and transparency. DeFi is a revolutionary technology, and understanding its risks will help us use resources more efficiently to achieve our goals in this field (Majumdar & Gochhait, 2022). Decentralised Finance (DeFi) is the (r)evolutionary movement to construct a financial system based only on code, with no intermediaries—a movement that has grown from $4 billion to $104 billion in assets locked up in the previous three years (Meyer et al., 2022).

DeFi is built on decentralised networks, specifically blockchain, a decentralised and distributed ledger technology that securely, transparently, and immutably records transactions across numerous computers and peer-to-peer networks. These technologies operate without a centralised authority or intermediaries (Weingärtner et al., 2023).

Some general use cases for smart contracts include Developed web applications known as dapps or web3, representing a new web age (Gray, 2021). Lee (2019) discusses the creation, trading, and custody of new tokens or cryptocurrencies. Liu et al. (2020) discuss creating and managing self-sovereign identity for interaction with blockchains and users (Piñeiro-Chousa et al., 2023). Decentralised financial services, enabled by blockchain technology, can increase financial inclusion, facilitate open access, promote permissionless innovation, and open up new opportunities for entrepreneurs and innovators.

The advantages of decentralised Finance, the identification of existing business models, and a discussion of potential problems and limitations were also studied. Decentralised Finance, as a new field of financial technology, has the potential to transform the structure of modern Finance and provide a new canvas for entrepreneurship and creativity, highlighting both the benefits and limitations of decentralised business models (Y. Chen & Bellavitis, 2020). Regulators have expressed alarm over cryptocurrency, which is sometimes accompanied by an interest in state-backed alternatives (Paterson, 2024). Composability is crucial to DeFi's functionality, as evidenced by studies conducted on the working mechanisms and composability analysis of DeFi protocols across various sectors, including asset management, decentralised trading, lending and borrowing, derivatives, and stablecoins. Evidence shows that even though DeFi protocols offer distinct services, they have comparable implementation strategies. Because of their connectivity, money legos that improve the ecosystem's interoperability can be created. According to the research, DeFi's modularity and interoperability allow developers to innovate quickly and without hindrance, addressing privacy and data security issues and resulting in a more open and accessible financial system (Shah et al., 2023).

Evidence shows that the EGARCH and CGARCH models provide the most accurate predictions of bitcoin volatility out of the seven GARCH variations investigated. In particular, these models accurately represent the complex time-varying components driving volatility (CGARCH) and the asymmetric responses of volatility to positive and negative shocks (EGARCH). These insights are essential for investors, regulators,

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and other market players looking to control risks and make wise choices in the bitcoin markets (Kiranmai & Thangaraj, 2023).

While other GARCH models show good in-sample fits, the Realized-GARCH model performs better than the others in out-of-sample forecasts every time. The capacity of the Realized-GARCH model to capture the subtleties of bitcoin volatility dynamics beyond the data utilised for a model estimate is demonstrated by this superiority. By demonstrating the improved predictive performance of the Realized-GARCH model over traditional GARCH models, especially in out-of-sample settings, this work considerably adds to the body of current literature. Through its ability to accurately predict the volatility of cryptocurrencies, this study offers important new information on risk management, trading tactics, and making decisions in digital asset markets (Queiroz & David, 2023).

DeFi risks are frequently amplified by the severity of market failures (externalities and information asymmetries). After comparing the roles served by TradFi and DeFi (Aquilina et al., 2024), demonstrated how regulations to protect consumers, maintain market integrity, and ensure financial stability apply to DeFi. Finally, we propose a regulatory approach for DeFi that considers its unique characteristics and functions.

DeFi continues to disrupt established financial paradigms while introducing dangers requiring immediate attention. The framework, which focuses on important components such as smart contract security, decentralised identification, Oracle integrity, liquidity pool protection, governance mechanisms, and regulatory compliance, attempts to create a robust architecture capable of withstanding increasing threats (Sahu & Kumar, 2024).

Methodology

This study aims to provide an overview of the ecosystem, which can assess its risks and opportunities. In order to check the association between the year of the coin in which it was introduced and the market capitalisation of the respective companies' coins, chi-square hypothesis testing is being conducted. Henceforth, to capture the volatility in the cryptocurrency data collected from July 2023 to June 2024, daily closing price data for the top five cryptocurrencies regarding their market capitalisation was collected from https://www.coingecko.com/. For every coin, there are 365 observations in the dataset. Log returns of all the daily closing prices are calculated and used for further modelling.

The problem of determining a financial asset's volatility can be solved in several ways, but the Generalized Autoregressive Conditional Heteroskedastic (GARCH) models are frequently employed to determine the volatility of financial time series involving stock returns. The asymmetric character of stock returns is captured by two basic classes of such models: the exponential GARCH (EGARCH) and the GJR-GARCH (Agyarko et al., 2023).

The model used to represent the asymmetric volatility responses of cryptocurrencies is called the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model (X. Chen, 2023).

The EGARCH Model will follow the following equation:

*LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))*

Where: C(2)- Constant; C(3)-leverage term; C(4)-ARCH term; C(5)-GARCH term

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Additionally, the Glosten, Jagannathan, and Runkle Generalized Autoregressive Conditional Heteroskedasticity (GJR-GARCH) model was prepared to capture the asymmetric effects of volatility shocks(Yildirim & Victor Bekun, 2023).

Equation of GJR- GARCH Model will be:

*GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) + C(6)*GARCH(-1)*

Where: c(3) Constant; RESID(-1)^2*(RESID(-1)<0)- dummy varaible; RESID(-1)^2) - ARCH term;

GARCH(-1)- GARCH term

Risks Associated with Decentralised Transactions

Decentralised Finance (DeFi) transactions involve various risks, including technical, financial, regulatory, and operational factors (Kaur et al., 2023): Smart Contract Risk, Counterparty and Market Risk, Regulatory and Security Risk, Operational Risk and Liquidity Risk.

Many DeFi protocols use smart contracts to oversee transaction execution and fund management. However, they are code-based, and attackers can exploit any defects or weaknesses in the smart contract code to steal funds or disrupt the protocol's functionality. They face counterparty risk as although DeFi seeks to eliminate the need for intermediaries, users continue to interact with counterparties such as borrowers, lenders, and liquidity providers. There is always a risk that these counterparties will fail to meet their obligations, causing financial losses for other participants. Furthermore, DeFi markets can be highly volatile, with asset prices shifting dramatically due to factors such as speculation, market manipulation, and shifts in investor opinion. Participants in DeFi transactions are subject to market risks, which can lead to considerable losses if not managed effectively (Turillazzi et al., 2023).

Liquidity is critical to adequately operating DeFi protocols, allowing users to swap assets and withdraw monies as needed. However, some DeFi markets may experience liquidity concerns, especially for less popular assets or during market stress. This can make it difficult for users to complete transactions at the appropriate price or withdraw monies on time. DeFi operates in a continuously changing regulatory context, with different countries using different techniques to control decentralised financial activity (Aramonte et al., 2021). Regulatory uncertainty might pose risks for DeFi participants, such as legal and compliance difficulties, enforcement actions, or changes in regulatory standards that could affect the operation of DeFi protocols. Because of the massive sums of money that can be held in smart contracts and decentralised applications (DApps), DeFi systems are great targets for hackers and criminal actors. Hacking attacks, phishing efforts, rug pulls (when developers abandon projects and flee with funding), and other cyber dangers are all examples of security risks. Last but not least, DeFi protocols may encounter operational issues such as software defects, network congestion, outages, and governance disagreements. These operational risks can potentially interrupt protocol functionality, harm user experience, and result in financial losses or inefficiencies.

Despite the purpose of decentralisation, some components of DeFi platforms may be centralised, such as control over critical infrastructure, governance processes, or ownership of huge quantities of assets. Centralisation brings concerns such as power concentration, censorship, and single points of failure, all of which can impair the DeFi ecosystem's resilience and trustworthiness.

Top 20 Countries in adopting DeFi

The top 20 global DeFi adoption index (2023) is shown in Table 1 based on the data published by chainstatistics. The calculation of this index takes into account different variables. Monitoring the total number of people actively involved in DeFi platforms and protocols can reveal patterns in adoption. In DeFi protocols, TVL quantifies the total value of locked assets. Growing TVL is a sign of increased platform acceptance and trust in DeFi. Tracking the number of transactions made on DeFi systems can

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reveal information about the degree of uptake and activity. The vitality and expansion of the ecosystem may be gauged by counting the number of developers who contribute to and work on DeFi projects. Knowledge about the policies and regulations of the authorities in a certain area, like India, and how they affect the adoption of DeFi can be very helpful in setting the scene. The degree of social media conversations, forum participation, and event attendance can provide information about the interest and adoption levels.

Table 1. The 2023 Global Crypto Adoption Index Top 20

Country	Overall index ranking	Index score	On-chain DeFi value received	On-chain number of DeFi deposits	On-chain retail DeFi value received
United States	1	1	3	47	4
Vietnam	2	0.82	4	64	3
Thailand	3	0.68	5	46	5
China	4	0.62	2	113	2
United Kingdom	5	0.6	9	40	6
India	6	0.59	1	120	1
Netherlands	7	0.55	24	11	18
Canada	8	0.52	17	30	15
Ukraine	9	0.49	11	50	7
Poland	10	0.46	18	36	17
France	11	0.46	14	44	16
Australia	12	0.41	27	26	23
Turkey	13	0.4	13	61	14
Switzerland	14	0.38	31	8	34
Russia	15	0.36	10	77	12
Argentina	16	0.34	12	65	21
Brazil	17	0.32	6	110	13
Portugal	18	0.31	34	22	33
Hong Kong	19	0.3	33	14	47
Togo	20	0.3	32	34	29

Source/Credit: Chain analysis 2021 report

According to the ranking, the top 5 countries that adopted DeFi protocols in 2023 were the US, Vietnam, Thailand, China, and the UK. India is in the sixth position on this list. The fact that India heavily influences Defi adoption suggests that cryptocurrency investments are common and have a significant economic impact (Figure 2). It is prudent to state that the majority of Indian business entities and cryptocurrency investors are driving the adoption of Defi. In order to modernise and prepare India's financial system for the future, DeFi must be made widely available. India will top the DeFi adoption index when its people begin to accept it. Furthermore, it is interesting to observe that the top 20 nations are either, wealthy nations with established cryptocurrency markets or economies with significant institutional and specialised markets. This shows that high-income, industrialised nations with robust professional and institutional markets will have a greater chance of obtaining financial decentralisation (Ozili, 2022).

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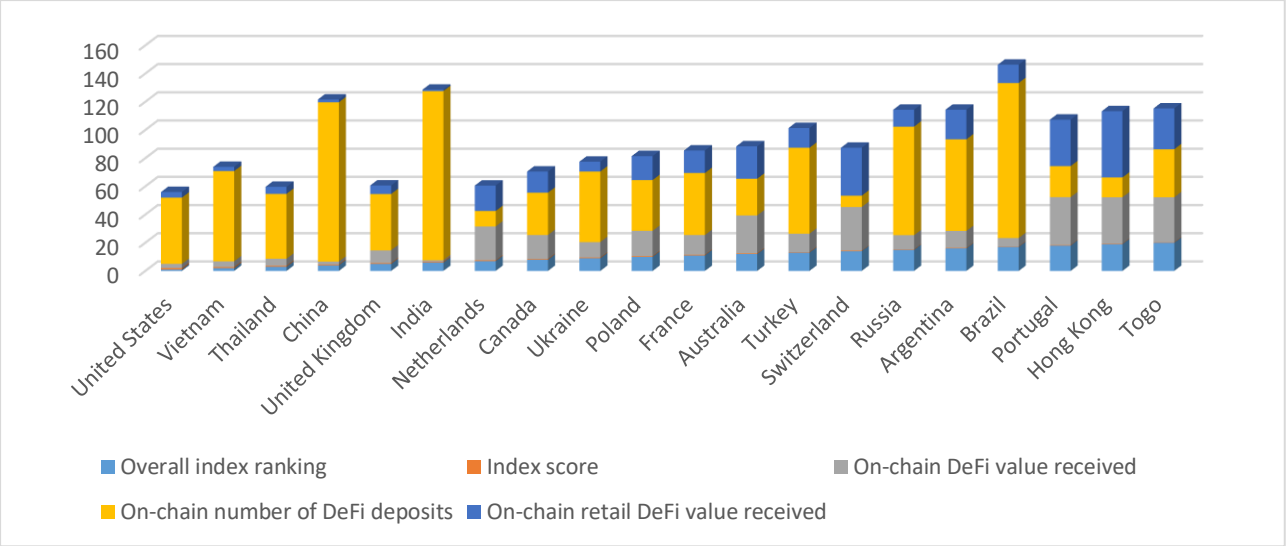

Figure 2. The 2023 Global Crypto Adoption Index Top 20

Source/Credit: Chain analysis 2021 report

Total Users of DeFi

DeFi technologies and projects have proliferated. Advancements in smart contract functionality and the creation of novel financial instruments have resulted in a wide range of DeFi applications that serve different financial services, such as asset management, trading, lending, borrowing, and insurance. More people are investigating and using these platforms due to their more user-friendly interfaces, educational materials, and the attraction of large yields and decentralised control.

The total number of users of DeFi protocols increased from 441 to over 49,862,394, according to Dune Analytics (Figure 3). This statistic represents a high percentage of increase in the total users of DeFi protocols from 2019 to 2024. The fewer users in 2019 and 2020 can be attributed to the vast uncertainties during the pandemic. People are more interested in using these highly specialised protocols (Shah et al., 2023). There has been a significant growth in the overall number of individuals involved with Decentralised Finance (DeFi). DeFi's promise to simplify access to financial services, provide higher rates, and give users more control over their money has helped it garner much attention. A growing interest in alternative financial systems that function in contrast to conventional banking frameworks is reflected in the spike in DeFi users. This pattern emphasises how decentralised platforms have the power to alter the financial industry fundamentally.

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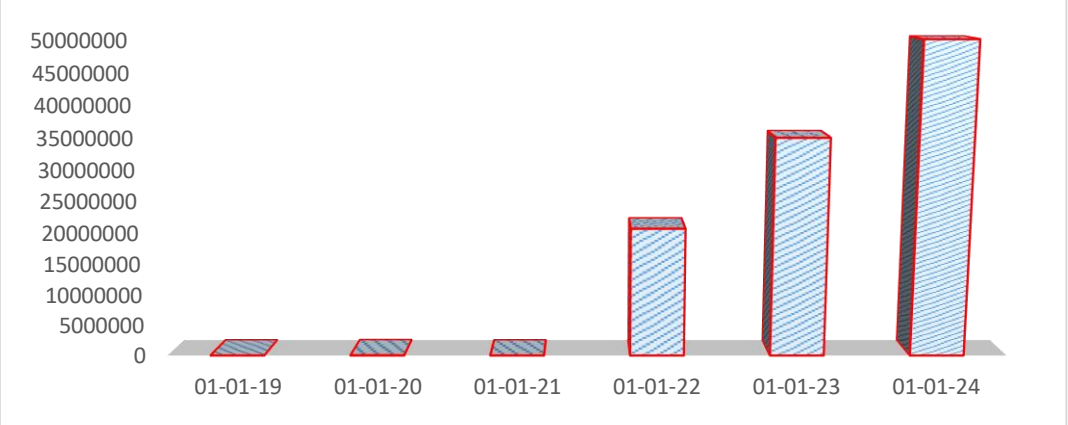

Figure 3. Total Defi Users Over Time

Source/Credit: Dune Analytics

Cryptocurrency Monthly Exchange Volume

The total value of all purchase and sell orders that are completed on cryptocurrency exchanges within a given month is referred to as the monthly exchange volume of cryptocurrencies. This measure shows how much trading was done in the Bitcoin market at a given time. Exchange volume information is commonly presented as the total amount of a certain cryptocurrency (such as Bitcoin or Ethereum) that has been traded against other cryptocurrencies or fiat currencies (such as USD or EUR). Figure 4 shows much fluctuation in the volumes of different cryptocurrency coins. A volume hike can be seen during the covid period as more transactions were done and peaked from April 2021 to June 2021.

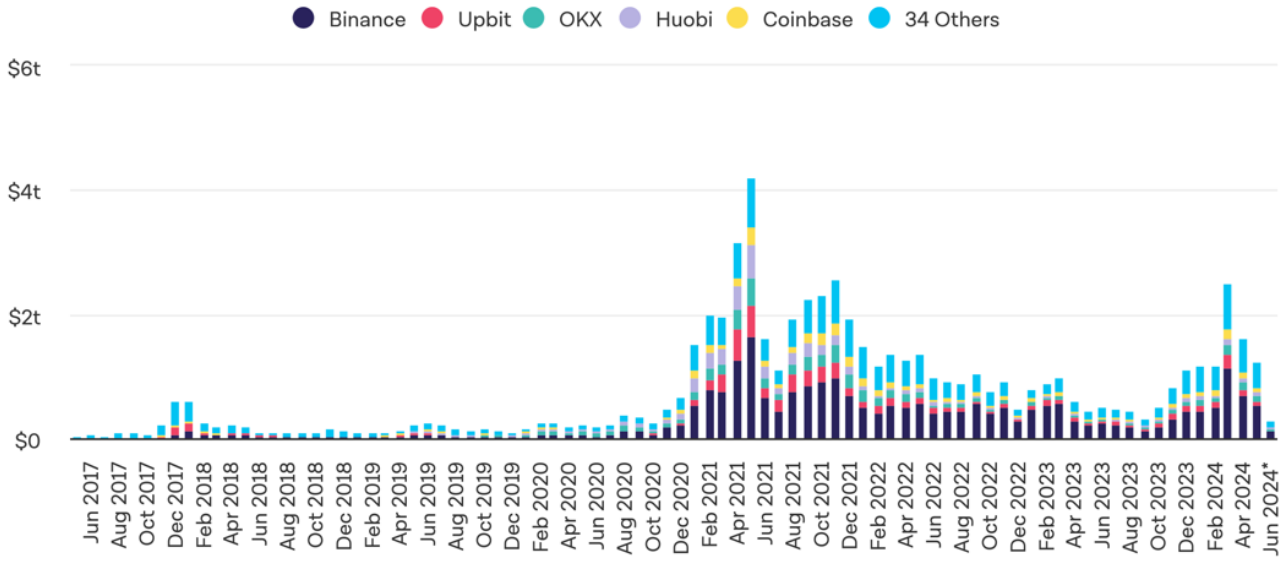

Figure 4. Cryptocurrency Monthly Exchange Volume

Source/Credit: The BLOCK

Results and Discussion

The market capitalisation of cryptocurrency companies is a crucial statistic because it provides insight into various cryptocurrency enterprises' relative importance and scale. Companies with larger market capitalisations are typically regarded as more valuable and powerful in the Bitcoin ecosystem. It is important to remember that several variables, including volatility in token prices, supply and demand, liquidity,

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investor sentiment, and general market circumstances, can affect market capitalisation. Many well-known cryptocurrency projects, including Tether, Solana (SOL), Ethereum (ETH), Bitcoin (BTC), and Binance Coin (BNB), rank among the largest by market capitalisation (Stanger, 2024). These companies' high market capitalisation values result from their frequent substantial user bases, robust technological platforms, vibrant development communities, and considerable market demand for their tokens. In order to check the association between the year of the coin in which it was introduced and the market capitalisation of the respective companies' coins, hypothesis testing will be conducted.

Hypothesis

H0: Market capitalisation of the top 20 cryptocurrency companies is equal in all three stages of age or year of introduction

H1: The market capitalisation of the top 20 cryptocurrency companies is not equal in all three stages of age or year of introduction

The Chi-square test of goodness of fit is applied to test this hypothesis as ther is one categorical data set.

$$X^2 = \sum \frac{(O - E)^2}{E}$$

- X^2 is the chi-square test statistic
- $\sum$ is the summation operator (it means "take the sum of")
- O is the observed frequency
- E is the expected frequency

All 20 cryptocurrencies are classified according to their age into development stages: early-stage, mid-stage, and late-stage.

Early Stage: 2006 – 20012

Mid Stage: 2013 – 2019

Late- Stage: 2020 and later

Table 2. Top 20 Cryptocurrency Coins Based on Market Capitalization

COIN	Market Capitalisation	Age of COIN/ Year of creation
Bitcoin BTC	$1,371,615,628,228	2009
Ethereum ETH	$443,005,008,645	2015
Tether USDT	$112,492,779,307	2015
BNB BNB	$102,122,301,601	2017
Solana SOL	$73,670,901,097	2020
Lido Staked Ether STETH	$35,070,797,303	2020
USDC	$32,196,732,971	2018
XRP	$27,645,538,449	2012

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Dogecoin DOGE	$21,067,321,366	2013
Toncoin TON	$17,327,486,544	2018
Cardano ADA	$15,570,945,132	2017
Shiba Inu SHIB	$13,714,667,975	2020
Avalanche AVAX	$12,895,545,794	2020
Wrapped Bitcoin WBTC	$10,641,166,560	2019
TRON TRX	$10,264,021,042	2017
Chainlink LINK	$9,445,589,545	2017
Bitcoin Cash BCH	$9,231,404,254	2017
Polkadot DOT	$8,860,177,504	2020
Uniswap UNI	$7,387,748,888	2018
NEAR Protocol NEAR	$7,008,638,029	2020

Source/Credit: www.coingecko.com

Hypothesis test results

Table 3. Market capitalisation (Observed vs Expected)

Age of Cryptocurrency	Market capitalisation	
	Observed	Expected
Early stage	2	6.67
Middle Stage	12	6.67
Later Stage	6	6.67

Source: Compiled by author using Excel

The chi-square test value is 7.596. Chi-Square Table Value at Degree of Freedom 2 and 0.05 Level of Significance = 5.99.

As the calculated chi-square test statistic is higher than the table value, there is not enough evidence to accept the null hypothesis, and thus, the null is rejected, and the alternate hypothesis is accepted. Hence, as per the results, the market capitalisation is not similar for all three categories/stages of the cryptocurrency age. The market capitalisation of a cryptocurrency coin is somewhat correlated to its launch year. Considering early cryptocurrencies like Bitcoin and Ethereum have had more time to become widely used, their market capitalisation may be bigger. However, if they provide cutting-edge technology or address certain issues, more recent cryptocurrencies may potentially see a rapid increase in market capitalisation. However, the cryptocurrency markets exhibit significant volatility and are subject to a multitude of factors, including macroeconomic conditions, regulatory developments, investor mood, market trends, and technology improvements. These variables might affect a cryptocurrency company's market value more than its launch year.

Rapid technical developments and innovation define this industry. Despite its relatively recent arrival, a cryptocurrency company that entered the market later may have created cutting-edge technologies or business strategies that draw investors and increase its market value. System implications, in which a cryptocurrency's value rises as more users and participants join its network, are frequently advantageous to cryptocurrencies. If a cryptocurrency is launched later, it could still greatly impact the ecosystem if it has unique features, draws many users, or forms alliances with other players. Cryptocurrency pricing and market

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capitalisation can be greatly impacted by speculative activity and market sentiment. Market capitalisation changes unrelated to the introduction period may result from investors focusing more on the company's future prospects and projected potential than on its debut year.

Volatility

As mentioned, many factors are responsible for the volatility of cryptocurrencies, and due to high volatility, cryptocurrencies can pose major risks to traders and investors. Effective risk exposure management depends on having an adequate grasp of the variables causing volatility. Econometric models such as EGARCH (Exponential Generalized Autoregressive Conditional Heteroskedasticity) and GJR-GARCH models are prepared to capture time-varying volatility dynamics.

There is some correlation between the two series, as evidenced by similar patterns over time, although the magnitude of changes differs (Figure 5). The red series (Bitcoin price log returns) tends to show greater fluctuations than the black series (Bitcoin market cap log returns), indicating that Bitcoin's price might be more volatile than its market capitalisation. There are some synchronous movements, where both series show similar trends (peaks and troughs occurring around the same periods), suggesting a relationship between the price of Bitcoin and its market capitalisation. Figure 5 highlights the inherent volatility in the cryptocurrency market, both in terms of price and market capitalisation. The red series (Ethereum market cap log returns) tends to show greater fluctuations than the black series (Ethereum price log returns), indicating that Ethereum's market capitalisation might be more volatile than its price. There are some synchronous movements, where both series show similar trends (peaks and troughs occurring around the same periods), suggesting a relationship between the price of Ethereum and its market capitalisation.

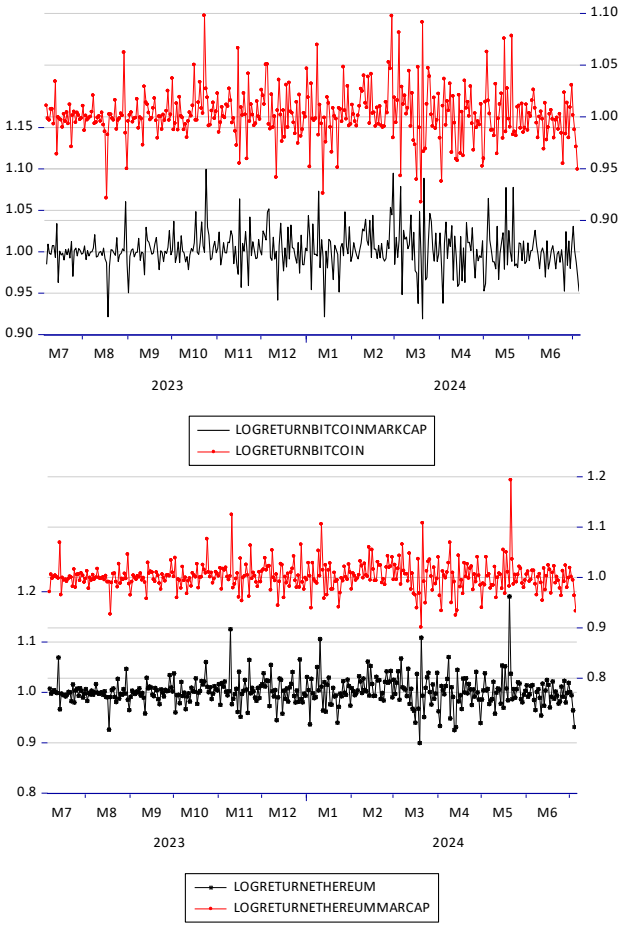

Figure 5. Market Capitalisation and Daily Closing Prices: Bitcoin & Ethereum

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Source: Compiled using Eviews

There are smaller fluctuations than other cryptocurrencies, which is expected given that Tether is a stablecoin designed to maintain a stable value (Figure 7). Market Capitalisation of Tether shows more pronounced spikes and dips compared to the black line, indicating changes in Tether's market capitalisation are more volatile than its price. There are some synchronous movements, where both series show similar trends (peaks and troughs occurring around the same periods), suggesting a relationship between the price of BNB and its market capitalisation.

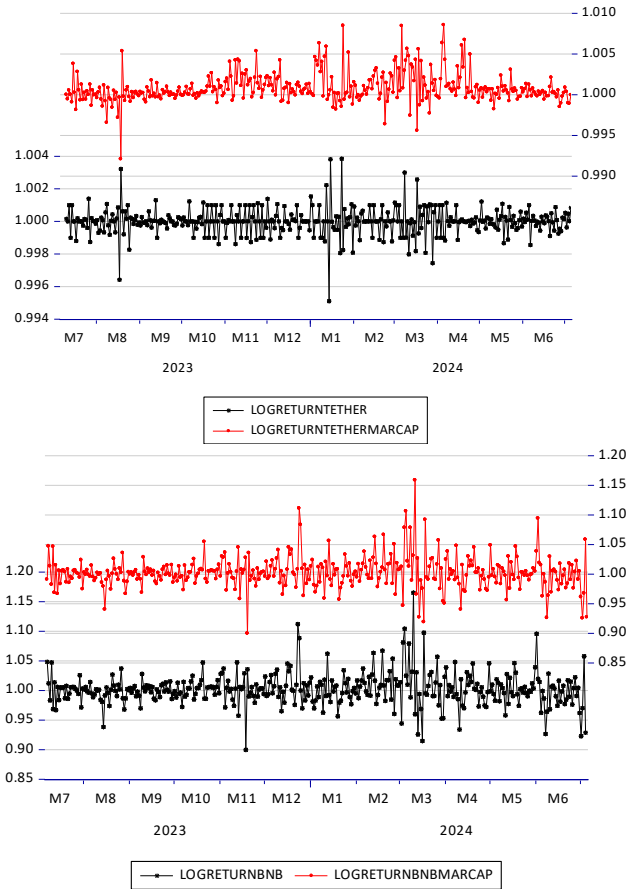

Figure 6. Market Capitalisation and Daily Closing Prices: Tether & BNB

Source: Compiled using Eviews

Figure 7 shows some synchronous movements, where both series show similar trends (peaks and troughs occurring around the same periods), suggesting a relationship between the price of Solana and its market capitalisation.

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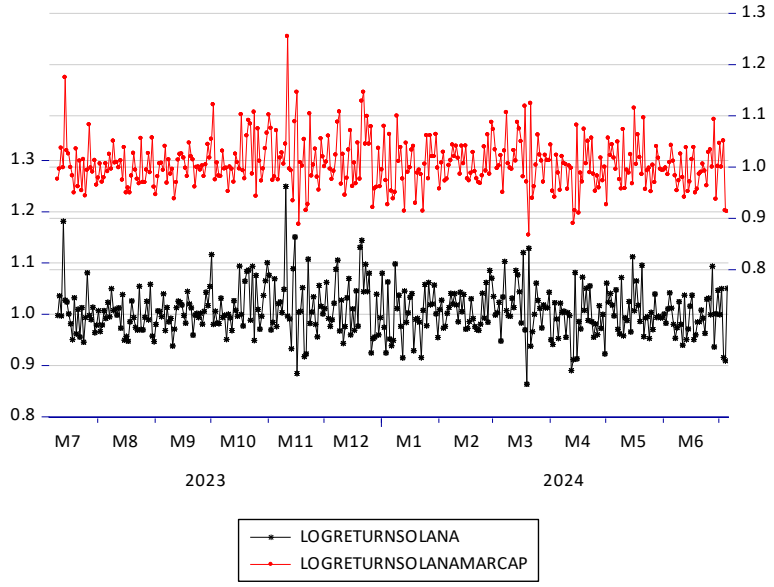

Figure 7. Market Capitalisation and Daily Closing Prices: Solana

Source: Compiled using Eviews

Solana (SOL) shows the highest mean (1.006216), suggesting higher average daily returns than others. Ethereum (ETH) and Solana (SOL) exhibit the highest maximum values (1.190495 and 1.249339, respectively), showing potential for significant daily gains (Table 4). Tether (USDT) has the narrowest range, indicating very low volatility. Solana (SOL) has the highest standard deviation (0.047997), indicating it is the most volatile. Tether (USDT) has the lowest standard deviation (0.000842), showing it is the least volatile and most stable.

Positive skewness for Bitcoin (BTC), Ethereum (ETH), BNB (BNB), and Solana (SOL) suggests a longer right tail, meaning more frequent larger positive returns. All cryptocurrencies exhibit kurtosis greater than 3, indicating leptokurtic distributions with fat tails, meaning higher probability of extreme returns. Negative skewness for Tether (USDT) suggests a longer left tail, meaning more frequent larger negative returns, but this is very minor. All cryptocurrencies have a Jarque-Bera statistic with a probability value of 0.000000, indicating strong rejection of the null hypothesis of normality.

Table 4. Descriptive Statistics: Closing Prices

	LOGRETURN BITCOIN	LOGRETURN ETHEREUM	LOGRETURN TETHER	LOGRETURN BNB	LOGRETURN SOLANA
Mean	1.0021	1.0018	1.0000	1.0024	1.0062
Median	1.0005	1.0004	1.0000	1.0020	1.0005
Maximum	1.0977	1.1905	1.0039	1.1651	1.2493
Minimum	0.9176	0.8994	0.9951	0.8997	0.8638
Std. Dev.	0.0246	0.0282	0.0008	0.0278	0.0480
Skewness	0.3954	1.0622	-0.1103	0.8328	0.7214
Kurtosis	5.6048	10.2295	9.3857	8.3304	5.0659
Jarque-Bera	112.3884	861.1401	615.7916	473.0147	95.7720
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	364.7554	364.6457	362.0003	364.8771	364.2503
Sum Sq. Dev.	0.2201	0.2895	0.0003	0.2803	0.8316
Observations	364.0000	364.0000	362.0000	364.0000	362.0000

Source: Author Estimated/Complied Using Eviews

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Solana's market capitalisation shows the highest mean (1.0064), suggesting higher average daily returns compared to others(Table 5). Solana's market capitalisation has the highest standard deviation (0.0480), indicating it is the most volatile. Tether's market capitalisation has the lowest standard deviation (0.0018), showing it is the least volatile and most stable. Tether's market capitalisation shows high positive skewness (0.9982), indicating a propensity for larger positive returns. Ethereum's market capitalisation has a particularly high kurtosis (10.3805), indicating a high likelihood of extreme values. All cryptocurrencies have a Jarque-Bera statistic with a probability value of 0.0000, indicating a strong rejection of the null hypothesis of normality.

Table 5. Descriptive Statistics: Market Capitalisation

	LOG RETURN BITCOIN MARKCAP	LOG RETURN ETHEREUM MARCAP	LOG RETURN TETHER MARCAP	LOG RETURN BNB MARCAP	LOG RETURN SOLANA MARCAP
Mean	1.0021	1.0017	1.0008	1.0023	1.0064
Median	1.0007	1.0006	1.0004	1.0022	1.0000
Maximum	1.0997	1.1933	1.0086	1.1585	1.2548
Minimum	0.9190	0.9008	0.9921	0.8996	0.8672
Std. Dev.	0.0245	0.0283	0.0018	0.0273	0.0480
Skewness	0.3957	1.1108	0.9982	0.7953	0.7497
Kurtosis	5.6637	10.3805	6.9735	8.0159	5.1270
Jarque-Bera	117.4297	903.4911	298.2643	421.1129	102.1425
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	365.7546	365.6175	362.3002	365.8505	364.3201
Sum Sq. Dev.	0.2177	0.2919	0.0012	0.2721	0.8322
Observations	365.0000	365.0000	362.0000	365.0000	362.0000

Source: Author Estimated/Complied Using Eviews

Egarch Test

The coefficient of leverage term in the case of bitcoin is negative as per results in Table 6. A negative coefficient indicates that positive shocks (good news) impact volatility differently than negative shocks (bad news), with bad news having a larger effect. The positive and significant coefficient of the ARCH term indicates that past shocks to returns affect the current volatility. The very high and significant coefficient of the GARCH term indicates a strong persistence in volatility. This means that past volatility has a significant influence on current volatility.

Table 6. EGARCH Test Results

Variable	LOGRETURN BITCOIN	LOGRETURN ETHEREUM	LOGRETURN TETHER	LOGRETURN BNB	LOGRETURN SOLANA
C	1.001223	1.001182	1.000048	1.002684	1.006685
Variance Equation					
C(2)	-0.051072	-8.822114	-5.199	-10.86628	-4.595859
C(3)	-0.064856	0.306091	0.710406	0.69422	0.39665
C(4)	0.034545	-0.33475	0.137441	0.177826	***0.094541****
C(5)	0.986794	***-0.1949****	0.671706	-0.40466	***0.298133****

source: Author Estimated/Complied Using Eviews

**insignificant at 5% level of significance, C(3)-leverage term, C(4)-ARCH term, C(5)-GARCH term*

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A positive and significant coefficient of leverage term in the case of Ethereum indicates that absolute past shocks (regardless of their direction) increase current volatility. The negative and significant coefficient of the ARCH term indicates that past positive shocks decrease current volatility. The negative coefficient of the GARCH term is not statistically significant (p-value > 0.05), indicating that past variances do not significantly impact current volatility in this model. This is atypical as the GARCH term is usually positive, representing volatility persistence. This finding supports the study of (Naimy et al., 2021; Yildirim & Victor Bekun, 2023).

The EGARCH model results for Tether indicate a low but persistent level of volatility, which is expected for a stablecoin. The significant positive leverage and ARCH terms suggest that absolute past shocks (both positive and negative) increase current volatility, though the effect is moderate compared to more volatile assets. The GARCH term's high significance indicates strong volatility persistence, meaning that past volatility significantly affects current volatility. R-squared: -0.003184 Adjusted R-squared: -0.003184 values are slightly negative, which can occur in time series models, particularly when the model explains very little of the variability in returns. This is common for stablecoins, where returns are usually very close to zero.

However, results for BNB indicate a low baseline volatility level, with significant leverage and ARCH effects indicating that absolute past shocks and recent volatility have substantial impacts on current volatility. The negative GARCH term suggests mean-reverting behaviour in volatility. The negative and significant coefficient of the GARCH term indicates that higher past volatility decreases current volatility. This is somewhat counterintuitive as it suggests mean-reverting behaviour in volatility, where periods of high volatility are followed by periods of lower volatility. The positive and significant coefficient of the leverage term of Solana indicates that absolute past shocks (regardless of their direction) increase current volatility. The ARCH & GARCH term is not statistically significant at conventional levels (p-value > 0.05), suggesting that recent past shocks to returns may not substantially impact current volatility for Solana.

GJR-GARCH

The GJR-GARCH model captures the dynamics of log returns of closing prices of cryptocurrencies and their volatility, incorporating both the lagged squared residuals and asymmetric effects of negative shocks on volatility.

Table 7. GJR-GARCH Test Results

Variable	LOGRETURN BITCOIN	LOGRETURN ETHEREUM	LOGRETURN TETHER	LOGRETURN BNB	LOGRETURN SOLANA
C	1.06422	1.057402	1.417682	0.988629	1.008858
LOGRETURN(-1)	***-0.06198****	***-0.057211****	-0.417704	***0.012852****	***-0.00407****
Variance Equation					
C	2.23E-05	2.29E-05	8.15E-08	5.39E-05	0.000151
RESID(-1)^2	0.048985	-0.016293	0.197167	0.28498	0.108768
RESID(-1)^2*(RESID(-1)<0)	-0.047997	0.055914	***0.051407****	-0.165537	-0.088277
GARCH(-1)	0.933605	0.96861	0.648622	0.745333	0.86018

source: complied using eviews

**insignificant at 5% level of significance, RESID(-1)^2*(RESID(-1)<0)-leverage term, RESID(-1)^2*

)-ARCH term, GARCH(-1)- GARCH term

The positive and significant coefficient for RESID(-1)^2*(RESID(-1)<0) indicates asymmetry in volatility, where negative shocks have a greater effect on increasing volatility compared to positive shocks(Table 7).

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In the case of Bitcoin, the coefficient of leverage term is negative, which specifies that after experiencing a negative shock in the previous period, the volatility tends to decrease rather than increase in subsequent periods. This suggests a form of volatility persistence where negative shocks are followed by periods of relatively lower volatility. Ethereum has a positive and significant leverage term coefficient, which means that negative news related to Ethereum will create more volatility than positive news. The coefficient of leverage term of Tether is also positive but insignificant. The negative coefficient of the BNB and Solana here suggests that when the previous residual is negative, the current volatility tends to decrease. These results are supported by (Stejskalova & Krampla, 2024).

Future of Decentralised Finance

As long as DeFi keeps addressing scaling concerns, enhances user experience, and works through regulatory obstacles, it could become more widely used. A wider audience may use DeFi as knowledge increases and the platforms become easier to use, surpassing the early adopters in adoption. There might be more compatibility between conventional financial systems and various DeFi protocols. This might make asset transfers easier and allow customers to use DeFi services straight from conventional banking platforms. By using smart contracts, the speed, cost and security of financial transactions increase and do away with the need for intermediaries (Ozili, 2022). It is anticipated that the DeFi industry will continue to innovate by introducing new financial services and products. Some examples are decentralised derivatives, synthetic assets, and more advanced loan and borrowing procedures. Expanding the variety of DeFi options might draw in more consumers and investors.

DeFi still faces major scalability issues, as evidenced by times when Ethereum's gas prices and network congestion were very high. Layer 2 protocols, sidechains, and alternate blockchains are examples of scalability solutions that could help with these problems and promote the development of DeFi. Security flaws and hazards could rise along with the DeFi ecosystem. It will need ongoing efforts to enhance security norms, audit procedures, and risk management techniques to safeguard user money and preserve confidence in DeFi platforms.

Conclusion

Within the financial industry, Decentralised Finance is a quickly expanding sector that uses smart contracts and blockchain technology to provide financial services openly, anonymously, and decentralised. The goal of this paradigm change from traditional centralised Finance (CeFi) to decentralised Finance is to reduce or even do away with the need for intermediaries while offering financial services that are more accessible, transparent, and efficient (Didenko, 2022). Overall, participants in these transactions must be aware of these dangers and take necessary precautions to reduce them, such as doing extensive due diligence, applying security best practices, diversifying their assets, and being up to date on regulatory developments. The statistics represent a high percentage of the increase in the total number of users of such protocols from 2019 to 2024. Indian users have expressed dedication to these protocols and platforms despite statutory uncertainty and obstacles. Numerous causes, such as the possibility of larger yields compared to traditional banking products, the accessibility of DeFi platforms, and the desire of India's sizable population for financial inclusion, are driving this movement.

Furthermore, the increasing accessibility of education resources and community support is probably helping Indian consumers embrace open financial habits. Nonetheless, to ensure the long-term expansion of the peer-to-peer financial system in India, it is imperative to keep an eye on regulatory developments. The association between the market capitalisation of the cryptocurrency companies was investigated with the age of the coin introduced in the market, as companies with larger market capitalisations are typically regarded as more valuable and powerful. Chi-square test results indicated that market capitalisation is not similar for all three categories/stages of the age of cryptocurrency. The market capitalisation of a cryptocurrency coin is somewhat correlated to its launch year. The cryptocurrency markets exhibit significant volatility and are subject to many factors, including macroeconomic conditions, regulatory developments, investor mood, market trends, and technology improvements. Each cryptocurrency analysed

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shows unique volatility patterns and behaviours captured by EGARCH modelling. Negative news tends to have more impact on Bitcoin than positive news, and the volatility is persistent and long-lasting. Ethereum, BNB & Solana see more volatility from absolute past shocks; however, Tether, being a stablecoin, exhibits a low but persistent level of volatility. This study is beneficial from the point of view of investors and stakeholders in evaluating the performance and future prospects of cryptocurrency companies, spot market patterns, and make wise investment selections in the industry.

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