A Comparative Market Research and Trend Analysis of Volatility in Decentralized and Regulated Markets

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1 Abstract

In this paper, we aim to compare the volatility of decentralized markets, such as cryptocurrency exchanges, with regulated markets, such as stock exchanges. The study analyzes various factors that contribute to market volatility, such as market size, liquidity, and regulations, among others. The research also compares the impact of market events, such as economic downturns or regulatory changes, on decentralized and regulated markets. Decentralized markets, including Bitcoin and Ethereum, utilize blockchain technology and offer advantages such as increased transparency, lower transaction costs, and quicker settlement times when compared to traditional regulated markets, however, these markets are also known for their higher volatility. Meanwhile, traditional regulated markets, such as stock and commodity exchanges, have also been subject to volatility as a result of macroeconomic factors such as inflation, geopolitical tensions, and changes in policy. Therefore, it is important to compare and analyze the volatility of decentralized and regulated markets to understand their behavior and potential risks. The purpose of this research paper is to conduct comparative market research and trend analysis of volatility in both decentralized and regulated markets. The study will investigate the factors that contribute to market volatility and examine historical trends. Additionally, the correlation between the volatility of these markets will be explored, and the potential impact of market volatility on investors and traders will be assessed. The research will involve data collection and analysis from a variety of sources, including market data, news articles, and academic studies. Ultimately, the paper will conclude with a discussion of the findings and their implications for traders and investors in both decentralized and regulated markets. Additionally, the study examines how different trading strategies and investor behaviors can affect market volatility in both types of markets. Overall, the research could provide valuable insights into the behavior of decentralized and regulated markets, which could be useful for investors, traders, policymakers, and other stakeholders.

Keywords : Blockchain, Stock Market, CryptoCurrency, Decentralized, GARCH Model, Regulated Markets

2 Problem Statement

Despite the growing popularity of decentralized markets, such as cryptocurrency exchanges, their volatility remains a significant concern for investors and traders. While some argue that decentralized markets are inherently more volatile due to their lack of regulation and infrastructure, others suggest that they may be more resilient to economic shocks and market manipulations. Therefore, there is a need to conduct comparative market research and trend analysis of volatility in decentralized and regulated markets to better understand their behavior and identify potential factors contributing to their volatility. Such an analysis could help investors and traders make informed decisions and policymakers design effective regulations for both types of markets.

3 Introduction

3.1 History of Stock Markets

Stock markets have been in existence for centuries. The origin of stock markets can be traced back to medieval Europe when merchants and traders used to gather at designated places to buy and sell goods. These gatherings were called ”fairs” and ”markets” where people traded goods and services for a profit. In the 17th century, the Dutch East India Company was the first to issue shares of its company to the public, which were traded on the Amsterdam Stock Exchange. Following this, the Philadelphia Stock Exchange was founded in 1790. In the 19th century, the New York Stock Exchange (NYSE) became the largest stock exchange in the world and remains one of the most important stock exchanges today. With the rise of the internet and digital technologies, stock markets have become more accessible to individual investors and traders, leading to increased participation and trading volumes. Today, there are numerous stock exchanges and trading platforms around the world, facilitating the buying and selling of stocks and other financial instruments.

Table 1: Comparative Analysis of Stock & Cryptocurrency markets

Property/Markets	Stock markets	Cryptocurrency markets
General Market Architecture	The general architecture of a stock market consists of various components that work together to facilitate the buying and selling of securities. The main components are as follows: **Stock Exchange:** The stock exchange is the primary platform where buyers and sellers come together to trade securities. Examples of stock exchanges include the New York Stock Exchange (NYSE) and the National Stock Exchange of India (NSE). **Brokers:** Brokers are the intermediaries between the buyers and sellers on the stock exchange. They help investors place buy and sell orders and execute trades on their behalf. **Clearing House:** The clearing house ensures that trades are settled and securities are delivered to the buyers and sellers in a timely manner. **Depository**: The depository is responsible for holding securities on behalf of investors in electronic form. **Regulators:** Regulators oversee the functioning of the stock market and ensure that all participants adhere to the rules and regulations, thus, performing a significant role in functioning.	The general architecture of the crypto market refers to the structure and function of the overall global market for cryptocurrencies, including the networks, exchanges, wallets, and other infrastructure facilitating the transactions related to digital assets. In general, the crypto market is decentralized, meaning that there is no central authority or institution controlling the market. Instead, transactions are validated and recorded on a distributed ledger called the blockchain, which is maintained by a network of users. Indian cryptomarket, on the other hand, operates under specific regulations and guidelines set by the Reserve Bank of India (RBI) and other government bodies. In 2018, the RBI imposed a banking ban on cryptocurrencies, preventing banks from dealing with cryptocurrency exchanges and traders. However, in 2020, the Supreme Court of India overturned the ban, opening up opportunities for the growth of the Indian crypto market. Since then, the market has seen increased activity, with new exchanges and trading platforms entering the market and offering innovative solutions to Indian customers.
The behavior of the market with respect to monetary policy and regulatory bodies	An example of the behavior of stock markets with respect to monetary policy and regulatory actions can be seen in the response of the stock market to the actions of the U.S. Federal Reserve. The Federal Reserve sets monetary policy in the United States by adjusting interest rates and implementing various policies to influence the money supply and inflation. Similarly, regulatory actions can also have an impact on the behavior of the stock market. For example, if a new regulation is introduced that affects a particular industry, such as increased taxes or stricter environmental standards, this can lead to increased costs for businesses in that industry, which can lead to a decrease in corporate profits and ultimately a decrease in stock prices. Conversely, if regulation is introduced that provides benefits to a particular industry, such as tax breaks or government subsidies, this can lead to increased profits and a subsequent increase in stock prices.	Cryptocurrencies are decentralized digital assets that are not directly impacted by monetary policies and regulatory actions of traditional financial systems. However, they can still be indirectly affected by such policies and actions through their impact on investor sentiment and adoption rates. For example, in the United States, the The securities and Exchange Commission (SEC) has been taking regulatory actions against companies and individuals involved in initial coin offerings (ICOs) and other cryptocurrency-related activities. This has also had an impact on investor sentiment and adoption rates, as individuals and companies become more cautious about investing in the crypto market. Overall, while cryptocurrencies may not be directly impacted by monetary policies and regulatory actions, they are still subject to their effects through their impact on investor sentiment and adoption rates.

Factors affecting Volatility of the market	There are several factors that can affect the volatility of stock markets. Some of the key factors include: **Economic indicators:** Economic indicators such as, GDP, inflation rates, and interest rates can have a significant impact on the stock market. Lower interest rates may stimulate borrowing and spending, leading to higher stock prices. Conversely, higher interest rates can lead to reduced spending and lower stock prices. **Political events:** Political events, such as elections, wars, and changes in government policies, can have a significant impact on the stock market. Investors may react positively or negatively to political events depending on how they perceive the impact on the economy and the stock market. **Company news and earnings reports:** Company news, such as mergers and acquisitions, new product launches, and earnings reports, can impact the stock market. Positive news can result in higher stock prices, while negative news can lead to lower prices. **Market sentiment:** Market sentiment refers to the overall mood or feeling of investors towards the stock market. Positive market sentiment can result in higher stock prices and vice versa. **Global events:** Global events, such as natural disasters, pandemics, and geopolitical tensions, can impact the stock by creating uncertainty leading to increased volatility in the stock market. The COVID-19 pandemic was a recent instance of an incident influencing stock market volatility. The epidemic wreaked havoc on the world's economies and markets, leading to greater volatility. Worldwide stock markets plummeted, with the S and P 500 index plunging by more than 30 percent in only a few weeks. The volatility persisted throughout the year, as markets reacted to pandemic-related news, government stimulus initiatives, and other economic issues.	Cryptocurrency markets are also affected by various factors that can impact their volatility. Some of the main factors affecting volatility in cryptocurrency markets include: **Market demand:** Cryptocurrencies are decentralized and are not backed by any government or financial institution, meaning that their demand is largely based on market speculation and adoption. As demand for a particular cryptocurrency increases, its price tends to rise, which can lead to increased volatility in the market. **News and media coverage:** News and media coverage of cryptocurrencies can greatly impact their volatility. Positive news, such as a large financial institution investing in cryptocurrency, can lead to an increase in demand and price, while negative news, such as a government crackdown on cryptocurrencies, can lead to a decrease in demand and price. In addition to the regulatory framework, the Indian cryptomarket also faces unique challenges related to infrastructure, such as **limited access to high-speed internet** and **limited availability of exchanges and trading platforms.** However, despite these challenges, the Indian cryptomarket continues to grow and evolve, with increasing interest and participation from Indian investors and traders. One example of an event that affected cryptocurrencies is the announcement by Tesla CEO Elon Musk in May 2021 that the company would no longer accept Bitcoin as payment due to environmental concerns related to the energy consumption of Bitcoin mining. This caused a sharp decline in the price of Bitcoin and other cryptocurrencies, as many investors saw this as a negative signal for the long-term viability of Bitcoin as a mainstream currency. Other events such as regulatory announcements, security breaches, and major adoption by institutional investors can also impact the volatility of cryptocurrency markets.

3.2 Existing Methodology

One of the previous methodologies for stock market volatility trend analysis is the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model. This model is widely used in finance to model the volatility of financial time series data, such as stock prices. The GARCH model assumes that the volatility of a financial time series is a function of its past values and past shocks, where the shocks are unexpected deviations from the expected value. The model estimates the conditional variance of the financial time series, which is used to forecast the volatility in the future. Another methodology for stock market volatility trend analysis is the ARIMA (Autoregressive Integrated Moving Average) model. This model is used to model time series data and has been applied to the analysis of stock market volatility trends. The ARIMA model estimates the autocorrelation and partial autocorrelation of the time series data and uses these estimates to model the trend and seasonality of the data. Other methodologies for stock market volatility trend analysis include the ARCH (Autoregressive Conditional Heteroskedasticity) model, the EWMA (Exponentially Weighted Moving Average) model, and the VAR (Vector Autoregression) model. These models have been used to analyze the volatility of financial time series data and to make predictions about future trends.

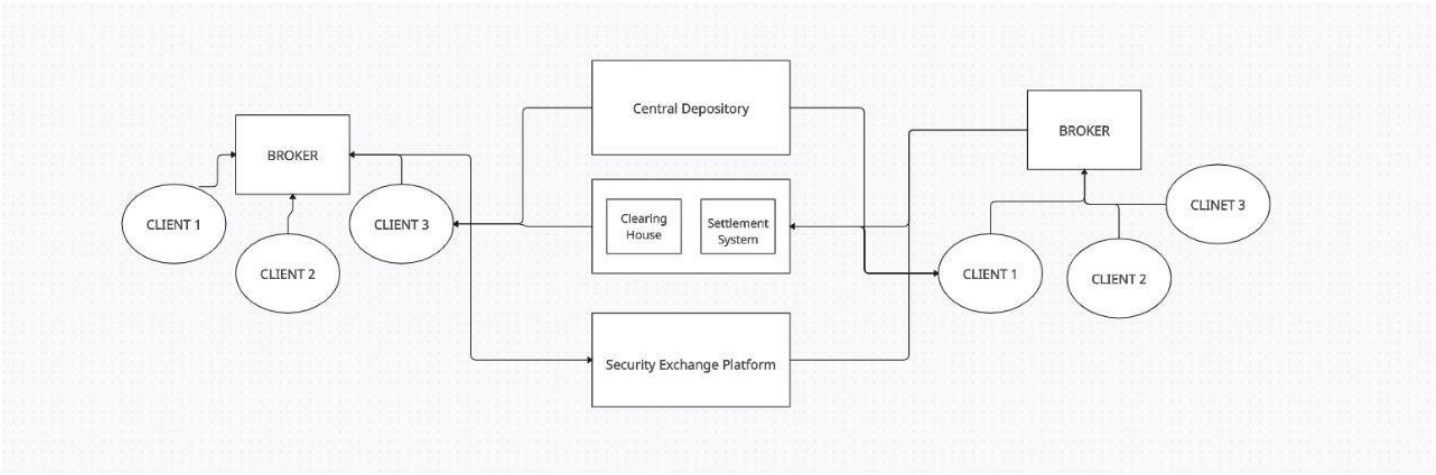

Figure 1: Architecture of the Stock Exchange

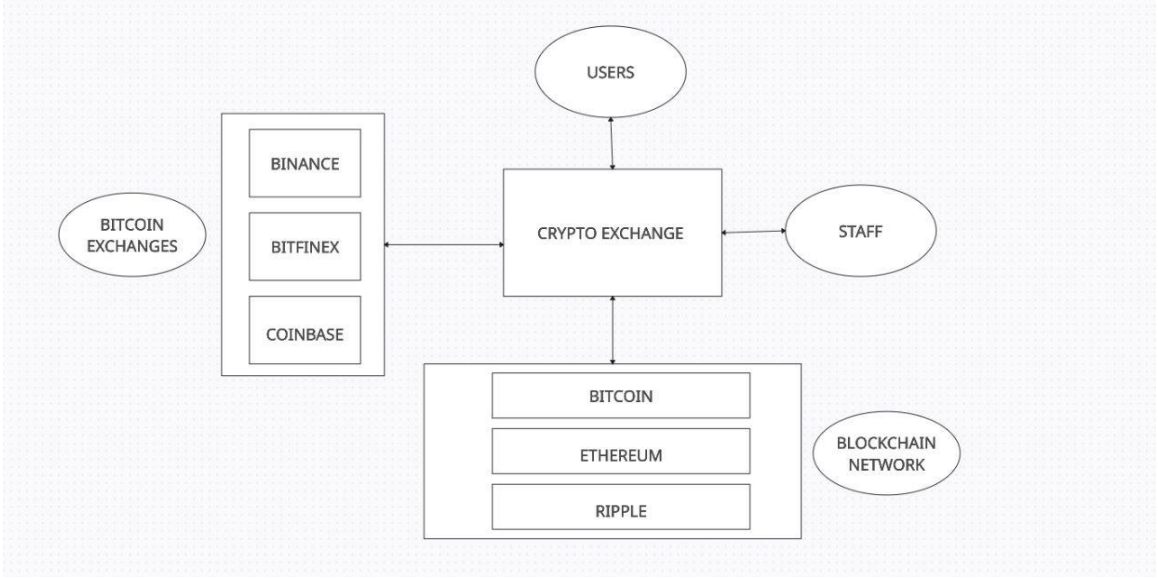

Figure 2: Architecture of the Decentralised market

3.3 Modeling volatility

A GARCH (Generalized Autoregressive Conditional Heteroscedasticity) model is an econometric model used for analyzing and forecasting volatility in financial markets. There are several types of GARCH models that are commonly used for the analysis of the stock market volatility. Some of the most common types are:

- GARCH(1,1) Model: This is the most widely used GARCH model, which assumes that the conditional variance of the series is a function of the past squared errors and past conditional variances
- IGARCH Model: Integrated GARCH model assumes that the conditional variance is a the function of past errors and variances, along with past volatility shocks.
- EGARCH Model: This model assumes that the conditional variance is a function of the past conditional variances, the absolute value of past errors, and the asymmetric response of the conditional variance to positive and negative shocks.
- TGARCH Model: Threshold GARCH model assumes that the conditional variance of the series is a function of past conditional variances, past errors, and past volatility shocks, with a different function for positive and negative shocks.
- CGARCH Model: Component GARCH model assumes that the conditional variance of the series is a function of past conditional variances, past errors, and past volatility shocks, with separate functions for the short- and long-term components
- NGARCH Model: Nonlinear GARCH model assumes that the conditional variance of the series is a function of

past conditional variances, past errors, and past volatility shocks, with a nonlinear function for the relationship between past errors and conditional variances

The choice of the GARCH model to use depends on the specific characteristics of the data being analyzed and the research questions being addressed.

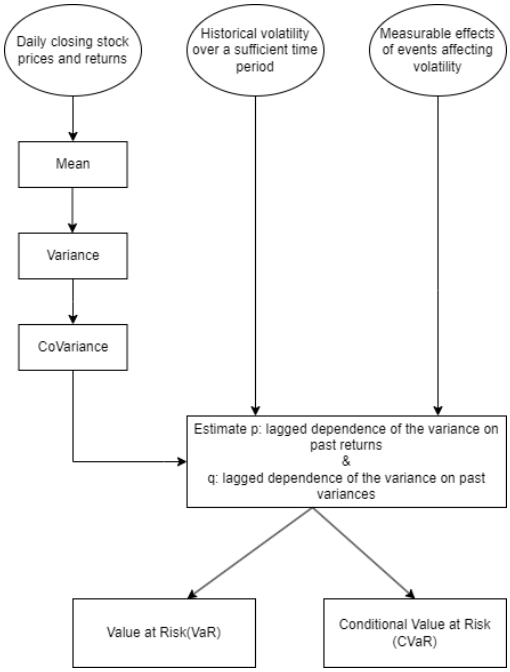

Figure 3: Architectural diagram of GARCH model

4 Proposed Methodology

The GARCH(p,q) models are widely used to perform a time series analysis of daily stock market data. The models are used in finance to capture the volatility clustering phenomenon observed in financial time series, where periods of high volatility are followed by periods of high volatility and vice versa. Collection of daily stock market data from a reliable source, such as Yahoo Finance or Bloomberg is done to include the daily returns of the stock market, which can be calculated as the percentage change in the market index from one day to the next. Further, the mean and variance of the daily stock market returns are calculated. The mean return is simply the average daily return over the sample period, while the variance is the average squared deviation of the returns from their mean. The model has two parameters: p, which captures the lagged dependence of the variance on past returns, and q, which captures the lagged dependence of the variance on past variances. The parameters of the GARCH(p,q) model can be estimated using maximum likelihood estimation (MLE). MLE is a statistical method that estimates the parameters of a model by maximizing the likelihood of observing the data given the model. In this case, the likelihood is the probability of observing the daily returns given the GARCH(p,q) model. Once the parameters of the GARCH(p,q) model are estimated, the model can be used to forecast the conditional variance of the stock market returns. The conditional variance is the variance of the returns given the information available up to that point in time. To test the residuals for autocorrelation and heteroscedasticity, we need to standardize them by dividing them by the forecasted volatility. The resulting standardized residuals represent the deviation of the actual returns from their expected values, given the estimated GARCH(p,q) model. Heteroscedasticity refers to the presence of time-varying variance in the residuals. We can test for autocorrelation and heteroscedasticity using statistical tests such as the Ljung-Box test and the ARCH-LM test, respectively. If the residuals exhibit autocorrelation or heteroscedasticity, we need to adjust the GARCH(p,q) model accordingly. This can be done by adding more lagged terms to the model or by using a different model that better captures the dynamics of the time series. Finally, the GARCH(p,q) model can be used to compute the Value at Risk (VaR) and Conditional Value at Risk (CVaR). VaR is a measure of the maximum loss that a portfolio is likely to incur over a given time horizon.

The step-wise procedure can be explained as follows :

- Collect daily stock market data
- Calculate the mean and variance of the stock market

returns

- Estimate the GARCH(p, q) model for the stock market returns
- Estimate the parameters of the GARCH(p, q) model using maximum likelihood estimation
- Use the GARCH(p, q) model to forecast the conditional variance of the stock market returns
- Compute the standardized residuals by dividing the actual returns by the forecasted volatility
- Test the residuals for autocorrelation and heteroscedasticity
- Adjust the GARCH(p, q) model if needed
- Compute the Value at Risk (VaR) and Conditional Value at Risk (CVaR) using the GARCH(p, q) model

Table 2: Comparative analysis of existing work

Paper Title	**Essence**	**Suggested Future Scope**	**Specific methodology and contents**
Safe haven, hedge and diversification for G7 stock markets: Gold versus Bitcoin [14]	A distinguished analysis of the relationship between Bitcoin (and gold) and the stock markets and potential safe haven abilities under adverse market conditions as well as of hedging effectiveness and conditional diversification benefits based on G7 countries from July 20, 2010, to December 31, 2018.	Nil	Comparative analysis and testing
Asymmetric volatility in equity markets around the world [7]	This paper investigates the asymmetric volatility effect in 19 equity indices around the world. Three symmetric volatility models with their asymmetric counterparts, namely, the GARCH with GJR-GARCH, Log-GARCH with E-GARCH, and HARRV with its asymmetric counterpart LHAR-RV.	Nil	Volatility modeling
Outliers and Time-Varying Jumps in the Cryptocurrency Markets [5]	The key findings indicate the price volatility in various major cryptocurrencies, highlighting the need of accounting for big shocks and time-varying surges while predicting volatility in the controversial cryptocurrency marketplaces.	Dynamic portfolio allocation	Outlier analysis
GARCH Modelling of Cryptocurrencies [3]	Pioneering work to provide GARCH modelling of the most popular cryptocurrencies namely, Bitcoin, Dash, Dogecoin, Litecoin, Maidsafecoin, Monero and Ripple. Fits of twelve GARCH models for each cryptocurrency are assessed in terms of five criteria furnishing conclusions based on the best fitting models, forecasts and acceptability of value at risk estimates.	Empirical developments, fiting multivariate GARCH-type models, Usage of expected shortfall instead of value at risk	GARCH modeling
Decentralizing the Stock Exchange using Blockchain [12]	A decentralized solution for the BVB Stock Exchange Market to solve the disadvantages of regulated architecture and lower transaction costs imposed by brokers and central authorities. We include stock market components into a blockchain architecture, together with smart contracts that allow self-enforcement of published orders.	Integration of state channel	Blockchain architecture, Technical implementation
A Triplicate Smart Contract Model using Blockchain Technology [6]	The framework improves the efficiency and practicability of using smart contract for physical assets and non-financial services with emphasis. The contribution is mainly on ensuring an adoptable and practicable smart contract platform.	Smart Oracle	Triplicate smart contract model, Technical implementation

Exploring the Dynamic Relationships between Cryptocurrencies and Other Financial Assets [4]	An analysis of the relationships between three popular cryptocurrencies and a variety of other financial assets in the time and frequency domains.	Monetary policy, Regulatory arbitrage	Statistical analysis
A study on Volatility in Indian Stock Market [9]	An effort to comprehend the inter- and intra-day volatility in the Indian regulated market in relation to the BSE Sensex.	Nil	Tabular analysis
Inter-markets volatility spillover in U.S. Bitcoin and Financial markets [13]	This research explores the volatility spillover dynamics between Bitcoin in the United States and financial markets implying a minimal amount of connectivity and contagion between US Bitcoin and financial markets.	Micro-level spillover analysis between crypto-currencies,	Volatility spillover indexing
Centralized and Decentralized Bitcoin Markets: Euro vs USD vs GBP [10]	In terms of return volatility and interdependency, the US dollar and British pound sterling (GBP) are contrasted, as well the centralised and decentralised bitcoin cryptocurrency markets.	Generalized Autoregressive Score (GAS) framework	Correlation analysis
Decentralized Regulation for a Decentralized Cryptocurrency [11]	A decentralized regulation to develop self-sustaining and robust systems capable of adapting to changing conditions in the bitcoin ecosystem without depending on central authority for regulatory action.	Nil	decentralized regulatory architecture
Copula-quantile causality from trading volume to return and volatility in the cryptocurrency market [2]	Copula-quantile causality is a method for modelling the combined distribution of variables, followed by quantile regression in order to estimate the conditional quantiles of a single variable provided a definite value of the other variable. In this example, it is utilized to investigate if trade volume has a causal influence on cryptocurrency market return and volatility, especially Bitcoin.	Time- varying result of causality	Copula-quantile causality
The relationship between implied volatility and cryptocurrency returns [1]	An analysis of the relationship between the price volatility of a broad range of cryptocurrencies and that of implied volatility of both United States and European financial markets as measured by the VIX and VSTOXX respectively.	Nil	Relationship analysis, Implied volatility
Uniswap and the rise of the decentralized exchange [8]	The use of ARDL and VAR techniques over a dataset of 999 hours of Uniswap trading to explore the influence of simplicity in enabling liquidity vendors and arbitrageurs to guarantee the reserve ratio matches the trading pair price.	Maximization of LP wealth, Addition of uncorrelated asset to investor portfolios	ARDL, VAR techniques

5 Literature review

Volatility is important in the secondary market since it has a large impact on investment decisions. Joan et.al [7]. investigated the asymmetric volatility effect in 19 major market indices. Most of the equity markets investigated had asymmetric volatility, meaning that negative shocks have a greater influence on volatility than positive shocks. Three symmetric volatility models with their asymmetric counterparts include the GARCH with GJR-GARCH, Log-GARCH with E-GARCH, and HARRV with its asymmetric counterpart LHAR-RV. Peter et al. [6] presented a Triplicate Smart Contract Model in their work "A Triplicate Smart Contract Model Using Blockchain Technology" to eliminate the need of brokers and increase security. This approach is made up of three smart contracts that work together to assure the security and efficiency of transactions. The initial contract serves as a basis for constructing other contracts and provides transaction rules. The second contract serves as a validator, ensuring that transactions are proper and that rules are followed. A third contract serves as an escrow account, keeping assets safe until the transaction is finalized. The authors suggest that because all parties engaged in the transaction are able to observe and verify the rules and consequences, this

triple smart contract approach is a more secure and transparent method to conduct transactions. The study also analyzes the model's possible uses in supply chain management, banking, and real estate. Overall, the report proposes that the triple smart contract approach might increase both security and efficiency while also contributing to blockchain adoption. Shehzad et al.[14] give a comparison examination of the possible functions of gold and Bitcoin for the stock markets of the G7 countries from July 20, 2010, to December 31, 2018, in their paper "Safe haven, hedge, and diversification for G7 stock markets: Gold versus bitcoin." The paper investigates gold and bitcoin's roles as safe havens, hedges, and diversification assets for the G7 stock market. While both gold and bitcoin may serve as safe havens, bitcoin is more volatile. Gold is a greater hedge against stock market volatility than Bitcoin, and both serve as diversifiers. However, historically, gold has been a more successful diversification asset than Bitcoin. The report proposes that investors investigate both gold and Bitcoin, but gold's lengthy track record and minimal volatility should be prioritized. In their work "Exploring the Dynamic Relationships between Cryptocurrencies and Other Financial Assets," Shaen et al.[4] go deeply into the time and frequency domains, analyzing the interactions between three notable cryptocurrencies and a number of other financial assets. The first GARCH modeling of the seven most prominent cryptocurrencies is presented in this study. Each cryptocurrency is fitted with twelve GARCH models, and their matches are evaluated using five criteria. The best-fitting models, projections, and acceptance of value-at-risk estimations are used to derive conclusions. High transaction costs, a lack of transparency, and vulnerability to cyber assaults are all problems with today's centralized stock exchanges. Claudia et al.[12] note the occurrence of outliers and time-varying leaps in the cryptocurrency markets in their work "Decentralizing the Stock Exchange Using Blockchain," while others suggested a mechanism for recognizing and analyzing the described occurrences. Outliers and leaps have become more common over time, and these occurrences are related to greater volatility and trading activity in bitcoin markets. According to the study "Uniswap and the Rise of the Decentralized Exchange," DEXs like Uniswap have the potential to disrupt existing centralized exchanges, leading to increasing decentralization of the cryptocurrency ecosystem. Venkataramanaiah's work [9], "A Study on Volatility in the Indian Stock Market," provides an in-depth analysis of the Indian stock market and volatility. The study's major goal is to investigate the aforementioned two characteristics of volatility in order to reduce excessive swings in the market. The purpose of this article is to learn about the inter- and intra-day volatility in the Indian stock market in relation to the BSE Sensex. It aided us in raising general knowledge of volatility and its many varieties, as well as doing more study on methods to analyze it. The trajectory of the BSE Sensex from 1990 to 2007, with 1000-point increments, time to attain, and P/E ratio is also illustrated. On July 25, 1990, the Sensex reached its first 1000 points after being introduced as a BSE index. It took 267 days to gain another 1000 points, however, it only took 40 days to reach 4000 points with a P/E ratio of 52. This P/E ratio is the greatest in the history of the sensex. This time saw the largest stock market swindle in Indian history. Harshad Mehta's price-fixing may have contributed to the period's boom. It took roughly 7 years for the company to advance from its prior 4000 pints. There was another long trek for the Sensex to get from 5000 to 6000 points. It takes roughly three years to attain this level. The 7000-point barrier was attained on June 21, 2005, after 370 days and with a P/E ratio of 15.6%. Within one year, the Sensex rose from 8000 to 13000 points, but it took another year to reach the all-time high of 20,000 points in 2006-2007. Observing the trend of the Sensex, one can immediately recognize the spark in the Sensex and the low P/E ratio compared to the preceding time of research.

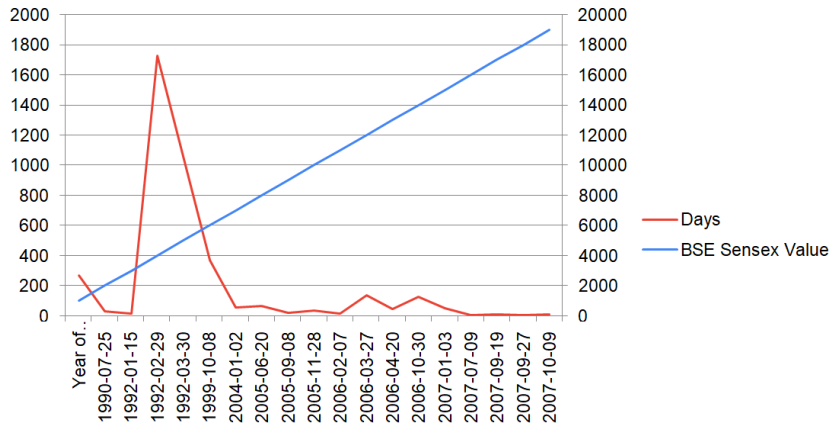

Figure 4: Intra-day (High to Low) Volatility on Sensex during 1998-2008

6 Module Description

6.1 Essential terms related to Stock Markets

The Indian stock market has some unique features such as:

- **Trading hours:** The trading hours for the Indian stock market are from 9:15 am to 3:30 pm, Monday to Friday.
- **Circuit limits:** Circuit limits are imposed by the stock exchanges to prevent excessive price movements in securities. In India, circuit limits vary depending on security and can range from 2% to 20%
- **Taxation:** India has a securities transaction tax (STT) that is levied on all stock market transactions. The STT is currently 0.1% of the transaction value for delivery-based trades and 0.025% for intraday trades.
- **Demat accounts:** In India, investors are required to have a demat account to hold securities in electronic form. This has helped in reducing the time and cost involved in settling trades.

6.2 Role of SEBI

In India, the responsibility for the regulation of stock markets lies with the Securities and Exchange Board of India (SEBI). SEBI (Securities and Exchange Board of India) is a regulatory body that oversees and regulates the securities market in India. The stock market is a crucial component of the Indian economy, and SEBI plays a vital role in maintaining the integrity and transparency of the stock market. SEBI's primary objective is to protect the interests of investors by ensuring fair practices in the securities market. It regulates stock exchanges, brokers, and other market intermediaries to ensure that they comply with the rules and regulations that govern the securities market. SEBI also promotes investor education and awareness, making investors aware of their rights and responsibilities while investing in the stock market. It ensures that listed companies provide complete and accurate information to investors and that they comply with the disclosure requirements. The work of SEBI is crucial in maintaining the stability of the stock market and preventing fraud and misconduct. SEBI has the power to investigate and penalize entities that violate securities laws, which helps to maintain investor confidence in the stock market.

6.3 Blockchain Technology and the Emergence of Crypto Markets

Blockchain is a distributed digital ledger technology that enables secure, transparent, and tamper-proof transactions without the need for a central authority or intermediary. It offers several benefits, such as:

- **Decentralization:** Blockchain eliminates the need for a central authority to validate transactions, reducing the risk of corruption or fraud.
- **Security:** Transactions on a blockchain are secured using advanced cryptographic techniques, making it difficult for malicious actors to tamper with the data.
- **Transparency:** Transactions on a blockchain are publicly visible, providing a high degree of transparency and accountability.
- **Efficiency:** Blockchain-based transactions can be processed quickly and at a lower cost compared to traditional financial systems

The crypto markets came into existence with the creation of Bitcoin in 2009 by an unknown person or group of people using the pseudonym Satoshi Nakamoto. Bitcoin was designed as a decentralized digital currency that could be used for peer-to-peer transactions without the need for a central authority or intermediary.

6.4 Indian Cryptomarket and specific trade requirements

The requirements for cryptocurrency trading vary depending on the exchange or platform being used. However, some common requirements include:

- **Account registration:** Traders must create an account with the exchange or platform and provide personal information such as their name, email address, and proof of identity.
- **Funding the account:** Traders must deposit funds into their account before they can begin trading. This can be done using bank transfers, credit cards, or other payment methods supported by the platform.
- **Understanding of the market:** Traders should have a basic understanding of cryptocurrency trading, including how to read charts and place orders.
- **Security measures:** Traders should take steps to secure their accounts, such as using two-factor authentication and keeping their passwords safe
- **Compliance with regulations:** Traders must comply with any applicable regulations related to cryptocurrency trading, such as anti-money laundering laws and tax reporting requirements

6.5 Autocorrelation

Autocorrelation is a statistical concept which measures the degree to which a series of observations are correlated with themselves over time. In other words, autocorrelation measures the similarity between observations at different time points in a time series. It is also known as serial correlation or lagged correlation. Autocorrelation is important in time series analysis, as it can help identify patterns or trends in the data, and can be used to forecast future values.

7 Proposed Architecture

7.1 Modeling the volatility analysis

The architecture of a GARCH model for analyzing stock market volatility will have the following components:

- **Conditional Mean Equation:** This equation describes the relationship between the the current value of the stock market index and its past values. A common model used for this purpose is the autoregressive (AR) model, which assumes that the current value of the index is a linear function of its past values.
- **Conditional Variance Equation:** This equation describes the relationship between the the current variance of the stock market index and its past values. A GARCH model assumes that the variance of the index is a function of its past values as well as the past values of its squared residuals.
- **Error Term:** The error term in a GARCH model is assumed to be normally distributed with zero mean and constant variance
- **Maximum Likelihood Estimation:** The parameters of the GARCH model are estimated using maximum likelihood estimation. This involves finding the values of the parameters that maximize the likelihood of the observed data given the model.
- **Volatility Forecasting:** Once the parameters of the GARCH model are estimated, the the model can be used to forecast future volatility of the stock market index.

7.2 Results analysis

- **Larger sample size:** Increasing the data sample size can result in more accurate estimations of model parameters and lessen the influence of outliers.
- **Alternative distributional assumption:** The GARCH model implies that the error component has a normal distribution, whereas financial data frequently has non-normal distributions. The model's performance can be improved by using a more appropriate distributional assumption, such as a Student's t-distribution or skewed-t distribution.
- **Varying lag lengths:** The GARCH model's performance can be influenced by the lag lengths used. Choosing proper lag lengths can increase the model's capacity to capture volatility persistence.
- **Higher-order model:** The conventional GARCH model for conditional variance is a first-order autoregressive process. Higher order models, on the other hand, can capture more complicated volatility dynamics.
- **Incorporating extra factors:** The GARCH model may be expanded to incorporate further explanatory variables, such as macroeconomic factors, which may influence the volatility of the series being modelled. Adding more variables to the model can increase its capacity to capture variations in volatility.
- **Regime switching:** Changes in volatility regimes may be captured using regime-switching GARCH models, which can lead to enhanced forecasting accuracy. The model can better reflect variations in the fundamental volatility process by enabling the volatility dynamics to transition between distinct states.

8 Conclusion

8.1 Optimization benefits

Improving the accuracy and reliability of volatility analysis in financial markets requires optimising current models. The optimisation procedure entails altering the model's parameters and assumptions to enhance performance and better represent the underlying market dynamics. To begin, the accuracy of volatility estimates may be enhanced by altering model parameters and assumptions. In the case of the ARCH and GARCH models, for example, optimising the model parameters can increase the model's fit to historical data and the accuracy of the volatility projections. Second, optimising current models can aid in the reduction of bias and improvement of the consistency of volatility projections. For example, if a model continually overestimates volatility, adjustments may be required. Third, optimizing current models can aid in the identification of possible flaws or limits in the models and the development of new techniques to solve these concerns. This might result in the creation of new models or changes to current models.

8.2 Contributions

Our paper is related to a growing strand of literature on the volatility of the regulated Stock markets and the decentralized Bitcoin and other major cryptocurrencies. The trend analysis and comparative research includes examples of sudden spikes and plunges in the prices of global equity indices over the previous years. Notably, Bitcoin and other major cryptocurrencies experienced large increases in their prices from the second quarter of 2020 until most of 2021, driven by an accentuated trend towards digitalization and acceptance of Bitcoin as a means of payment by large corporations as well as possibilities of central banks and emerging economies to adopt cryptocurrencies.

9 Future Scope

The various forms of GARCH models, other modeling techniques and optimization measures suggested can be implemented to refine the overall results of the volatility analysis. Major contributions include an exploratory analysis of the applied methodology and techniques of the existing literature which enlists the future scope of research on the associated topics. Several models and variation of independent variables is possible to produce precise results with higher accuracy. Comparative trend analysis of the regulated and decentralized nature of markets has an ever growing significance for the investors and fund managers.

References

[1] E. Akyildirim, S. Corbet, B. Lucey, A. Sensoy, and L. Yarovaya. The relationship between implied volatility and cryptocurrency returns. *Finance Research Letters*, 33:101212, 2020.

[2] E. Bouri, C. K. M. Lau, B. Lucey, and D. Roubaud. Trading volume and the predictability of return and volatility in the cryptocurrency market. *Finance Research Letters*, 29:340–346, 2019.

[3] J. Chu, S. Chan, S. Nadarajah, and J. Osterrieder. Garch modelling of cryptocurrencies. *Journal of Risk and Financial Management*, 10(4):17, 2017.

[4] S. Corbet, A. Meegan, C. Larkin, B. Lucey, and L. Yarovaya. Exploring the dynamic relationships between cryptocurrencies and other financial assets. *Economics Letters*, 165:28–34, 2018.

[5] A. Dutta and E. Bouri. Outliers and time-varying jumps in the cryptocurrency markets. *Journal of Risk and Financial Management*, 15(3):128, 2022.

[6] P. Eze, T. Eziokwu, and C. Okpara. A triplicate smart contract model using blockchain technology. *Circulation in Computer Science-Special Issue*, pages 1–10, 2017.

[7] J. B. Horpestad, Š. Lyócsa, P. Molnár, and T. B. Olsen. Asymmetric volatility in equity markets around the world. *The North American Journal of Economics and Finance*, 48:540–554, 2019.

[8] Y. Lo and F. Medda. Uniswap and the rise of the decentralized exchange. 2020.

[9] V. Malepati. A study on volatility in indian stock market. *Available at SSRN 2890890*, 2016.

[10] R. Matkovskyy. Centralized and decentralized bitcoin markets: Euro vs usd vs gbp. *The Quarterly Review of Economics and Finance*, 71:270–279, 2019.

[11] H. Nabilou. How to regulate bitcoin? decentralized regulation for a decentralized cryptocurrency. *International Journal of Law and Information Technology*, 27(3):266–291, 2019.

[12] C. Pop, C. Pop, A. Marcel, A. Vesa, T. Petrican, T. Cioara, I. Anghel, and I. Salomie. Decentralizing the stock exchange using blockchain an ethereum-based implementation of the bucharest stock exchange. In *2018 IEEE 14th International Conference on Intelligent Computer Communication and Processing (ICCP)*, pages 459–466. IEEE, 2018.

[13] M. O. Qarni, S. Gulzar, S. T. Fatima, M. J. Khan, and K. Shafi. Inter-markets volatility spillover in us bitcoin and financial markets. *Journal of Business Economics and Management*, 20(4):694–714, 2019.

[14] S. J. H. Shahzad, E. Bouri, D. Roubaud, and L. Kristoufek. Safe haven, hedge and diversification for g7 stock markets: Gold versus bitcoin. *Economic Modelling*, 87:212–224, 2020.

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