Comprehensive Analysis of Bitcoin and Comparison with Other Assets

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Abstract:

This study provides an econometric investigation of Bitcoin's return dynamics using daily data over 5.5 years from January 2020 to September 2025. This research deeply analyses the market behaviour of Bitcoin over other assets like Gold, Silver, Ethereum, Tether, Nifth50, BankNifty. In this analysis we used advanced time series and statistical models such as ARIMA, GARCH(1,1), Rolling GARCH, Half-Life estimation, and EGARCH models to evaluate conditional mean behavior, volatility clustering, persistence, asymmetric shock effects, and regime-dependent risk transmission. With the use of this models, rolling Garch reveals structural instability with persistence decline in later periods. EGARCH results asymmetric shock effects, where negative shocks increases volatility more than positive shocks. Forecasting models suggests that volatility will eventually return to its long term average, but risk is still expected to remain high for some time before normalizing. The analysis reveals strong conditional heteroskedasticity and near-integrated volatility persistence during crisis periods specific around the COVID-19 market collapse (2020), the FTX bankruptcy shock (2022), the April 2024 Bitcoin halving, and the 2025 Bybit exchange hack. Using various data visualizations, the analysis reveals high risky nature of Bitcoin trade with high returns compared to other assets. Deep learning model LSTM reveals the nature that closing price of next day is unpredictable as obvious in case of such high volatile nature of Bitcoin. These findings underline the importance and nature of trading in Bitcoin for individuals who are thinking to invest.

Keywords: Bitcoin, Assets, Volatility, Returns.

Introduction:

Due to the rapid development of information and communication technologies, many activities in Our daily life have been merged online and they become more flexible and more effective. A huge growth in number of online users has activated virtual world concepts and created a new business phenomenon which is Cryptocurrency to facilitate the financial activities such as buying, selling and trading. Virtual money is not fully controlled and regulated hence most of the countries have not admitted this currency in their economic activities. A Crypto currency is a Digital currency, which is an alternative form of payment created using encryption algorithms. This lead to the rise of Bitcoin.

Bitcoin originated with the white paper that was published in 2008 under the pseudonym Satoshi Nakamoto. Bitcoin price reached over 73,0000 USD in March 2024 and now it is 68,033 USD (as of Feb 22 2026). Since its introduction, Bitcoin has had a choppy and volatile trading history. Bitcoin was designed to be used as currency in daily transactions. While Bitcoin is a Cryptocurrency, investors have also used it to store value and hedge against inflation and market uncertainty. Bitcoin's price is a product of supply, demand, and market

sentiment. The creators original motivation behind Bitcoin was to develop a cash- like payment system that permitted electronic transactions. In Cryptocurrency to have different types of currency are Bitcoin, Ethereum, litecoin, Ripple etc. in which Bitcoin is well-known. Bitcoin in the world is fixed i.e. 21 million BTC, which introduces programmed scarcity similar to gold. In 2025, around 19.7 million BTC have already been mined that means only about 1.3 million are left to be created. Its Feature because of how many people trade in Bitcoin are firstly decentralized as they are not controlled by a single head or a government instead transactions are verified by a network of computers spread across globe.

Literature Review:

1. According to Hae Sun Jung and Haein Lee their paper Titled *"Bitcoin Research in Business and Economics: A Bibliometric and Topic Modeling Review"* maps and analyzes the intellectual structure of Bitcoin research within the Business and Economics domain. The highest number of Bitcoin related articles was published in 2023 (1010 articles). The highest number of Bitcoin-related articles was published in 2023 (1010 articles). Likely due to the time required for the publishing process including peer review, the price surges in 2021 and 2022 appear to have influenced the number of publications in 2022 and 2023. Overall, there has been a consistent upward trend since the first article in 2012, indicating growing scholarly attention toward Bitcoin. In terms of publication volume, China (735), the United States (555), and the United Kingdom (302) account for the largest shares. However, when considering citations per article as an indicator of influence, France records the highest average citations per article (46.27), followed by the United Kingdom (44.25) and

Australia (30.41). This indicates that publication volume does not directly correspond to scholarly impact. Business and Economics represents the largest share of Bitcoin-related publications (47.76%), followed by Computer Science (25.68%). Together, these two fields account for more than 70% of the total literature, indicating that academic inquiry into Bitcoin is crypto currencies like Bitcoin. Bitcoin's Blockchain Architecture This section delves into the specifics of Bitcoin's blockchain architecture, covering: - Blocks and Transactions: Discusses the primarily concentrated in economic/financial and computational perspectives.

2. According to Daeyun Kang, Doojin Ryu & Robert I. Web conducts bibliometric analysis to explore research trends in Bitcoin, identifying two primary perspectives in the recent financial economic literature: Bitcoin as a speculative asset and as a safe-haven asset. The speculative nature of Bitcoin is evident through its high volatility and frequent price jumps, largely influenced by rapid shifts in investor sentiment and attention, which create both risks and opportunities for traders. Conversely, Bitcoin exhibits characteristics of a safe-haven asset due to its asymmetric tail dependence and negative correlation within certain asset classes. Bitcoin's high volatility enables traders to gain or lose substantial amounts rapidly. Market participants will trade Bitcoin or its derivatives in the hope that their position will profit if prices rise if they are long or fall if they are short. . Research shows that the Bitcoin market deviates from the efficient market hypothesis, providing evidence through the long-term memory dependencies in time series and the strong correlation with investor sentiment. This indicates that the presence of long-term dependencies, showing that prices do not quickly reflect information and exhibit weak predictability, suggests that some speculative strategies that exploit this relationship might be

more profitable than one would expect if the market were informationally efficient.

3. According to Dr.Neha Bharani and Ms Prof. Nidhi Upadhyay presented their paper Titled" Blockchain Technology and Its Role in the Bitcoin Ecosystem A Review".In this research they studied Blockchain technology, introduced through the advent of Bitcoin, has revolutionized the way transactions and data are stored, verified, and maintained in a decentralized manner.

Purpose of the Research:

To help new investors understand the behavior of Bitcoin price movements, risks and perks of the same.

Source: finance.yahoo.com

Data size: 2020 to 2025

Statistical Tools: Autoregressive Integrated Moving Average(ARIMA), Generalized Autoregressive Conditional Heteroskedastisity (GARCH), Exponential GARCH, Correlation Matrix, Rolling GARCH.

Deep learning Tools: Long Short Term Memory (LSTM)

Objectives:

1. To do feature engineering and create columns of SMA, EMA and log returns for further analysis.
2. To predict next day closing price of Bitcoin using deep learning algorithm.
3. To Quantify conditional volatility persistence in Bitcoin returns.
4. To Identify structural breaks and regime shifts using rolling estimation.
5. To Measure asymmetric volatility responses to positive and negative shocks.
6. To Estimate shock half-life under varying market conditions.
7. Evaluate short-term mean and variance forecasting performance.
8. To forecast next 30 days price of Bitcoin.

9. To predict the life persistence of Bitcoin volatility aftershocks.

Methodology:

1. Feature Engineering:

The data that we got from yahoo finance consisted of features : Price, Close, High, Low, Open, Volume.

We added features like Simple Moving Average(SMA), Exponential Moving Average(EMA) and Log returns for further analysis.

2. ARIMA Model:

Purpose: Model conditional mean dynamics and forecasts next 30 days.

RMSE, MAE, MAPE, MASE. These are **forecast accuracy measures.** All coefficients have **very small standard errors.** Since in this analysis, most AR values are negative and close to -1 indicates strong persistence, High volatility clustering.

MAPE indicates Model prediction error is about 18%. The model captures general trend but short-term fluctuations remain unpredictable.

ACF1 ≈ 0. It means residual autocorrelation is almost zero. Market dynamics are well captured.

Bitcoin Forecast with Confidence Interval 2025
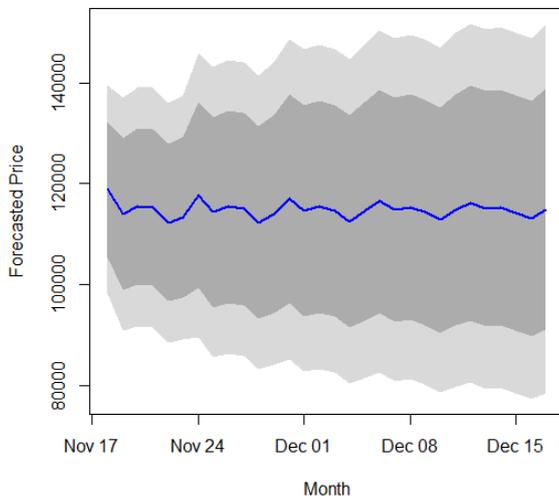
Actual Price 2025
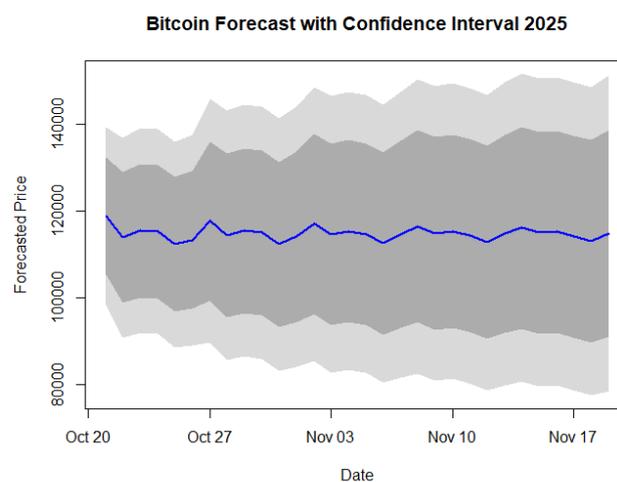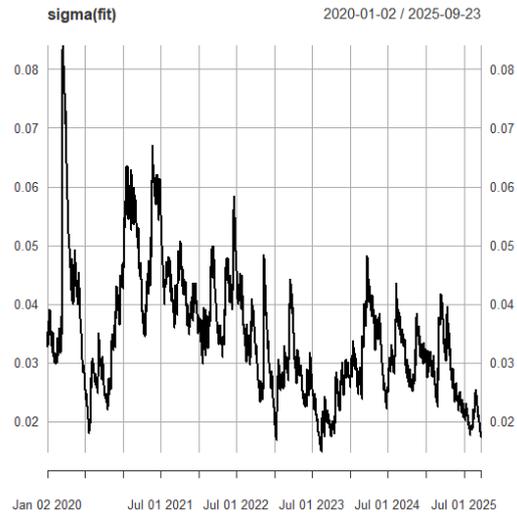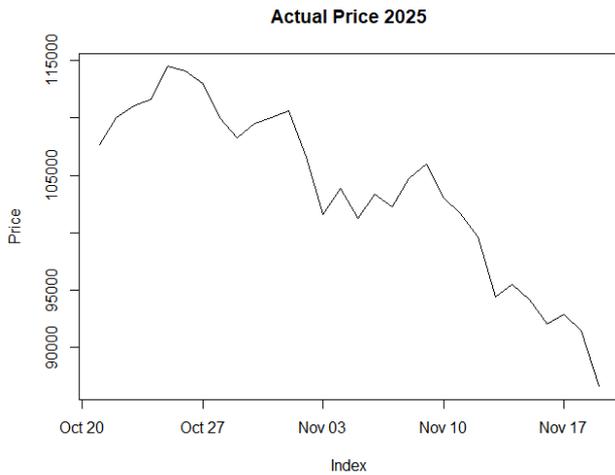
The shaded regions are Confidence Interval. Actual and forecasted prices are nearly same Forecast trajectory follows general trend. Bitcoin returns exhibit weak mean predictability consistent with near-random walk behavior. It means our model fits well.

Forecasted next 30 days:

Bitcoin Forecast with Confidence Interval 2025

3. EGARCH Model:

Purpose: Capture asymmetric volatility responses to positive and negative shocks.

sigma(fit)   2020-01-02 / 2025-09-23

Here, Asymmetric volatility present; leverage-type effect observed. Downward price movements during FTX collapse and hack events generate combined volatility spikes. This suggests Markets react more aggressively to adverse news than favorable developments. The dominance of the β parameter suggests that Bitcoin's current risk level is largely influenced by past market volatility rather than new information.
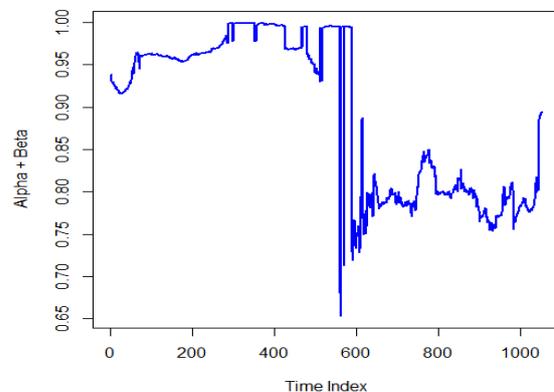
4. Rolling GARCH Persistence:

Purpose: Detect time-varying persistence and structural instability.

In this, if value of $\alpha + \beta$ close to 1 indicates very persistent means shocks last long, if value of $\alpha + \beta$ <0.8 indicates faster decay of shocks.

Rolling GARCH Persistence

```
> head(rolling_results)
    Date      alpha      beta persistence
1 11/5/2022 0.06902935 0.8685742  0.9376036
2 11/6/2022 0.06923268 0.8685810  0.9378136
3 11/7/2022 0.06963037 0.8686917  0.9383220
4 11/8/2022 0.06439892 0.8664782  0.9308771
5 11/9/2022 0.07790121 0.8508065  0.9287077
6 11/10/2022 0.08178046 0.8473908  0.9291713
```

Sharp persistence peak during FTX collapse indicates structural break; moderation after 2023 reflects partial stabilization. Volatility persistence is regime-dependent rather than constant.

Crisis periods intensify market sensitivity; stabilization reflects improving liquidity and maturity.

Reason behind decreasing spike:

April 2024 Bitcoin Halving & Volatility Spike:

The Bitcoin network underwent its fourth halving in April 2024—reducing miner The Bitcoin network underwent its fourth halving in April 2024—reducing miner from 6.25 to 3.125 BTC per block. While halvings are scheduled events, they often trigger speculative trading and volatility as supply shock expectations affect market pricing. Analysts estimate this halving had a meaningful impact on price movements around that period.

In February 2025, hackers stole approximately $1.5 billion in digital assets from the Bybit exchange in what became the largest crypto exchange hack on record. This cyber-attack spiked market fear, contributed to Bitcoin price declines

Economically, this suggests that Bitcoin experienced extreme uncertainty during global crisis conditions, followed by gradual stabilization.

5. Conditional Volatility Over time:

Rolling GARCH Volatility
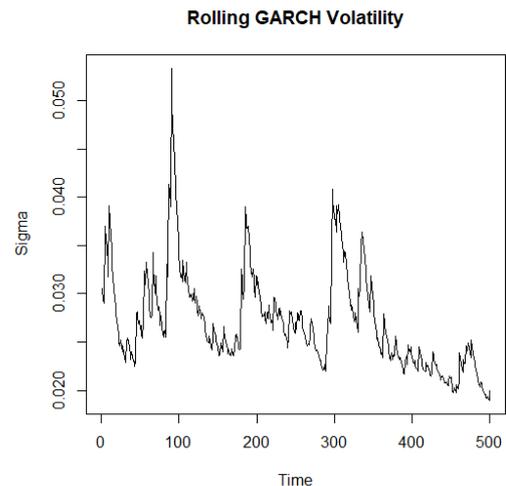
As the time index progresses, volatility gradually declines and becomes relatively more stable, with smaller fluctuations compared to earlier peaks. This indicates a reduction in conditional variance over time and suggests partial stabilization of the market. However, volatility never becomes completely flat, meaning Bitcoin continues to exhibit persistent risk. Overall, the results confirm that Bitcoin behaves as a high-risk, high-uncertainty asset, where volatility is predictable to some extent but remains structurally elevated compared to traditional financial equities, and commodities can help design more efficient diversified investment strategies.

6. UGARCH Volatility Forecast 2026:

The predicted daily volatility for the next 60 days.

2-Month GARCH Volatility Forecast 2026
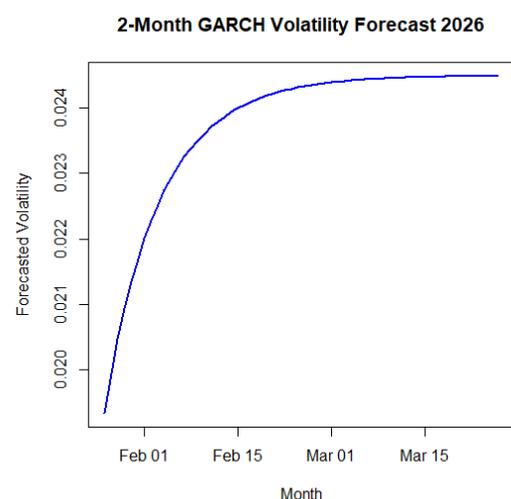
It starts from last observed date and forecasts forward. The y-axis represents conditional standard deviation of returns.

$0.024 \approx 2.4\%$ daily volatility. It means the model predicts daily return fluctuations of about ±2.4%.

The 60-day ahead forecast indicates a gradual increase in conditional volatility, converging toward the model's long-run variance. Current volatility is slightly below long-run equilibrium.

Bitcoin highly unpredictable. The later moderation in volatility suggests improving market maturity or reduced speculative intensity, but the asset still remains significantly more volatile than traditional financial assets. Overall, the graph confirms that Bitcoin is a high-risk asset characterized by episodic turbulence and persistent volatility.

7. Half Life of a Bitcoin:

In a GARCH model, **half-life** measures the number of periods required for a volatility shock to reduce to half of its initial impact.

From our analysis the half life volatility persistence :

For Big Shock → 330 days (~1 year)

For small shock → 22 days

Economically, this means that in recent periods, when Bitcoin experiences a volatility shock (due to news, macro events, or speculation), the impact lasts longer in the market. Earlier, risk levels normalized more quickly, but later the market reacts more persistently to shocks. This suggests increasing market sensitivity and prolonged uncertainty, making risk management more important for investors.

### 8. To compare Bitcoin with assets based on close price:

Average of Close by Year, Month and Asset

Asset ● BANKNIFTY ● BITCOIN ● ETHEREUM ● NIFTY50
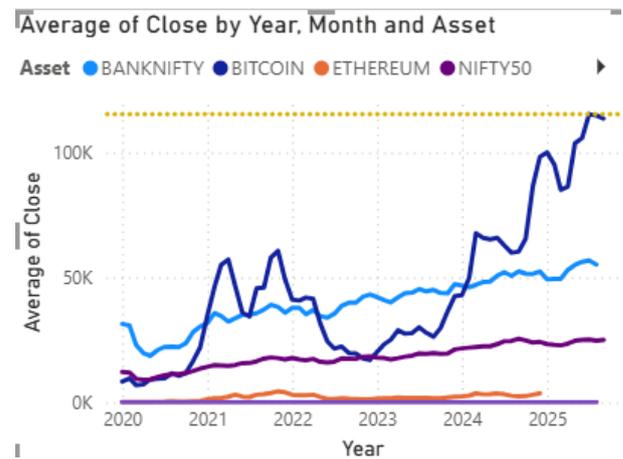
Bitcoin is highly volatile compare to Ethereum and other assets. Higher trading volumes tend to coincide with periods of strong price growth, especially in the case of Bitcoin.

9. To compare Bitcoin with other assets based on Volume and Close price over years:

Max of Volume and Max of Close by Year and Asset

Asset ● BANKNIFTY ● BITCOIN ● ETHEREUM ● NIFTY50 ● SILVER
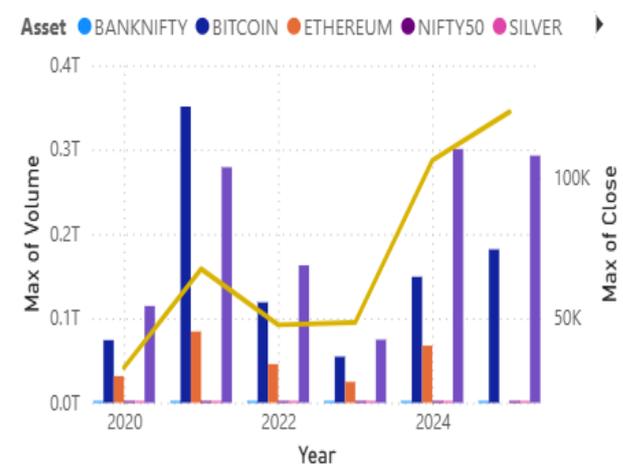
The chart indicates that Bitcoin consistently records the highest trading volume, especially in 2021 and again after 2023, reflecting strong investor activity during peak price movements. Nifty50 also shows relatively high volumes in recent years, while Bank Nifty and Ethereum display moderate fluctuations. Silver maintains comparatively low trading volume throughout the period. At the same time, the maximum closing prices rise significantly after 2023.

10. To check the correlation between assets:
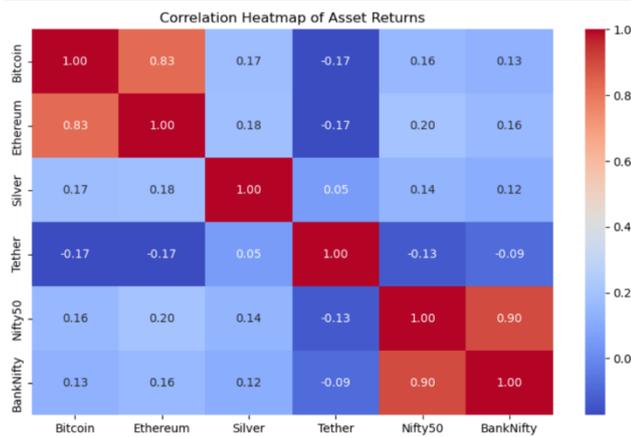
Bitcoin and Ethereum has very strong positive correlation(0.83). Crypto assets behave as one cluster. Investing in both may not give strong diversification benefit. Nifty50 and BankNifty has strong positive correlation(0.90). These two are highly overlapping. Holding both does not reduce portfolio risk significantly. Crypto and Indian equity markets are largely independent. This gives diversification opportunity. Silver has Low positive correlation with equities and crypto. Silver acts as a mild diversifier. It does not strongly move with crypto or stock market. Tether acts as a liquidity or safe asset in crypto ecosystem. When risky assets rise, Tether slightly declines, and vice versa.

11. LSTM Model:

We fit Long Short Term memory model to capture the long term dependencies of tomorrow's price with the previous ones.

LSTM R2 Score: 0.8801053381616928

The model successfully captured the overall trend of Bitcoin prices. Predictions are smoother because the model minimizes mean squared error. Slight lag is expected in time-series deep learning models.

Next day price prediction

Predicted Next Day BTC Closing Price (2024-01-01): $ 42474.215

Actual BTC Closing Price (2024-01-01) : $ 44167.33

Limitations

Financial markets are partially random and influenced by external events. Therefore, perfect prediction is impossible. The goal is trend capture, not exact price prediction.

Results and Key Findings:

1. Persistent volatility clustering across entire sample.
2. Structural breaks around 2020 and 2022.
3. Significant asymmetric volatility response.
4. Mean predictability limited; variance predictability strong.
5. Volatility gradually moderates post-2023 but remains elevated relative to traditional assets.

Overall Conclusion:

This research provides a comprehensive understanding of the trading behavior, risk characteristics, and predictability of Bitcoin in comparison with other assets such as Ethereum, Tether, Silver, NIFTY 50, and NIFTY Bank. The findings reveal that Bitcoin is a highly volatile yet high-return asset, making it attractive for investors with higher risk tolerance. Correlation analysis shows that assets within the same class move closely together, while cross-asset combinations provide better diversification benefits. Machine Learning models such as LSTM and ARIMA demonstrate that although Bitcoin prices exhibit strong time dependence and volatility clustering, exact price prediction remains difficult due to market uncertainty. The models are effective in capturing trends but not precise daily movements. Time Series Model - EGARCH captured time-varying risk in Bitcoin market.

Overall, Bitcoin behaves as a speculative and growth-oriented asset with significant return

potential, but it requires careful risk management and informed investment decisions.

Future Scope:

Future research can expand this study by including a longer time horizon and incorporating more global assets such as gold, crude oil, international indices, and emerging cryptocurrencies. The integration of macroeconomic variables like inflation, interest rates, geopolitical risk indices, and regulatory developments could improve predictive accuracy. Additionally, advanced deep learning architectures such as hybrid LSTM-GARCH models or Transformer-based models may enhance forecasting performance. Sentiment analysis using social media data and blockchain transaction data can also provide deeper insights into investor behaviour.

Limitations:

Despite meaningful findings, this study has certain limitations. The analysis is based on historical secondary data from 2020–2025, and financial markets are inherently uncertain and influenced by sudden economic, political, and global events. Bitcoin markets, in particular, are highly sensitive to regulatory changes, technological developments, and investor sentiment, which cannot be fully captured by statistical models. Although ARIMA, GARCH, and LSTM models provide strong trend analysis, no model can perfectly predict future prices because markets exhibit partial randomness and speculative behaviour. Therefore, the results should be interpreted as analytical insights rather than exact investment predictions.

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Data Source: finance.yahoo.com

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