FA595 Financial Technology

Business Proposal Report

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1 Part I: Cryptocurrency Ecosystem and Interlinkages

1.1 Introduction

Blockchain technology has been transforming the financial market in various aspects. Specifically, cryptocurrencies have emerged as a new asset class that attracts a huge amount of interest and capital investments around the world. The cryptocurrency industry is growing at a staggering pace, with over 21,000 different coins/tokens in existence and a total market capitalization exceeding $800 billion.

In this part of the project, we survey a subset of the cryptocurrency market and the blockchain ecosystem. We also perform empirical analysis on the interlinkages among various cryptocurrency assets and blockchain systems.

1.2 Selection of Five Cryptocurrencies

Our group selected five cryptocurrencies of interest, ensuring that each has daily price data available from January 1, 2022, to December 31, 2022, on Yahoo Finance. The selected cryptocurrencies are:

- **Bitcoin** (BTC-USD)
- **Ethereum** (ETH-USD)
- **Dai** (DAI-USD)
- **Monero** (XMR-USD)
- **Aave** (AAVE-USD)

We will analyze and discuss the following aspects for each cryptocurrency:

1. Data Integrity Check
2. Detailed Overview
3. Protocol Adoption
4. Rationale for Selection

1.2.1 Data Integrity Check

We performed a visual inspection of the data to ensure there are no missing entries during the sample period.

Data Downloaded for Cryptocurrencies and S&P 500:

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 364 entries, 2022-01-01 00:00:00+00:00 to 2022-12-30
    00:00:00+00:00
Freq: D
Data columns (total 6 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   AAVE-USD   364 non-null    float64
 1   BTC-USD    364 non-null    float64
 2   DAI-USD    364 non-null    float64
 3   ETH-USD    364 non-null    float64
 4   XMR-USD    364 non-null    float64
 5   ^GSPC      251 non-null    float64
dtypes: float64(6)
memory usage: 19.9 KB
None
```

Checking for Missing Values:

```
Ticker
AAVE-USD      0
BTC-USD       0
DAI-USD       0
ETH-USD       0
XMR-USD       0
^GSPC       113
dtype: int64
```

Missing Values After Filling:

```
Ticker
AAVE-USD    0
BTC-USD     0
DAI-USD     0
ETH-USD     0
XMR-USD     0
^GSPC       2
dtype: int64
```

Summary Statistics:

Table 1: Summary Statistics

Ticker	AAVE-USD	BTC-USD	DAI-USD	ETH-USD	XMR-USD
count	364.0000	364.0000	364.0000	364.0000	364.0000
mean	110.9702	28229.7603	0.9999	1989.5652	165.0744
std	50.4539	10193.6990	0.0006	775.1552	33.7672
min	49.4283	15787.2842	0.9983	993.6368	104.1831
25%	73.7618	19549.7808	0.9996	1295.4930	143.9975
50%	91.6953	23170.2598	0.9999	1686.5877	153.4604
75%	146.5679	39113.2627	1.0002	2763.9098	185.5129
max	267.0540	47686.8125	1.0023	3829.5649	279.3931

1.2.2 Overview of Each Cryptocurrency

Detailed overview of each of the selected cryptocurrencies is provided below.

1. **Bitcoin (BTC-USD)**

   - **Description:** Bitcoin is the first and most widely recognized cryptocurrency, created by an anonymous entity known as Satoshi Nakamoto in 2009.
     It operates on a decentralized peer-to-peer network and was designed as a digital alternative to traditional currencies.
     Bitcoin relies on a Proof of Work protocol, where miners compete to solve complex cryptographic puzzles in order to validate transactions and add them to the blockchain. This process requires significant computational power and energy consumption.
     The Bitcoin blockchain is public and permissionless: anyone can join the network and participate in transaction validation.
     Bitcoin's security is ensured through cryptographic techniques and the decentralized nature of its network, which together make it resistant to censorship and attacks.
   - **Market Position:** As of 2022, Bitcoin holds the largest market capitalization in the cryptocurrency market, often referred to as "digital gold."
   - **Significance:** Bitcoin serves as a decentralized store of value and a medium of exchange, influencing the development and perception of the broader cryptocurrency ecosystem.

2. **Ethereum (ETH-USD)**

   - **Description:** Ethereum is a decentralized, open-source blockchain featuring smart contract functionality, proposed by Vitalik Buterin in 2013 and launched in 2015.
     It is a decentralized platform that enables developers to build and deploy smart contracts and decentralized applications (dApps).
     Ethereum originally used a Proof of Work (PoW) protocol, but in December 2022,

it transitioned to Proof of Stake (PoS) with the Ethereum 2.0 upgrade. In the PoS model, validators replace miners and are selected to propose and validate new blocks based on the amount of cryptocurrency they "stake" as collateral, rather than competing to solve complex puzzles.

Ethereum is widely recognized for its ability to execute smart contracts: self-executing contracts where the terms of the agreement are written directly into code. This feature has made Ethereum the foundation for countless decentralized applications (dApps).

The Ethereum blockchain is also public and permissionless so to ensure the security and integrity of transactions, Ethereum employs a combination of cryptographic techniques and the security provided by its PoS consensus mechanism.

- **Market Position:** Ethereum ranks second in market capitalization, serving as the foundational platform for decentralized applications (dApps) and decentralized finance (DeFi).
- **Significance:** Ethereum's transition to Proof of Stake (PoS) enhances its scalability and energy efficiency, positioning it as a leader in smart contract platforms.

3. **Dai (DAI-USD)**

- **Description:** Dai is a decentralized stablecoin pegged to the US Dollar, managed by the MakerDAO protocol on the Ethereum blockchain.

  Unlike centralized stablecoins like USDT or USDC, Dai is decentralized and maintained through collateralized debt positions (CDPs) and the MakerDAO governance model.

  Dai maintains its peg to the US dollar via an over-collateralization model. Users lock up collateral (such as ETH or other crypto assets) in the MakerDAO system to mint Dai tokens. If the collateral value drops below a certain threshold, the system automatically liquidates the collateral to maintain the Dai peg.

  The MakerDAO protocol is governed by the holders of the MKR token, who vote on changes to the protocol, including the collateral types accepted, interest rates, and more. Dai's stability and security are ensured through smart contract mechanisms and the decentralized governance of MakerDAO.
- **Market Position:** Dai is one of the leading stablecoins, widely used in DeFi applications for lending, borrowing, and liquidity provision.
- **Significance:** Dai provides a stable medium of exchange within the volatile cryptocurrency market, enabling users to hedge against price fluctuations.

4. **Monero (XMR-USD)**

- **Description:** Monero is a privacy-focused cryptocurrency launched in 2014, utilizing advanced cryptographic techniques to provide confidential and untraceable transactions. It is designed to prevent transactions from being traced or linked to an individual, making it a popular choice for those seeking privacy.

  Monero operates on a Proof of Work consensus mechanism, similar to Bitcoin, but

it uses a unique hashing algorithm called RandomX. This algorithm is optimized for CPU mining and is specifically designed to be resistant to ASIC mining (which involves specialized hardware), ensuring a more decentralized mining process.
Monero is renowned for its strong privacy features, which include:
- Ring Signatures: These obfuscate the sender's identity by mixing their transaction input with others, making it difficult to trace the source of the transaction.
- Stealth Addresses: These ensure that the recipient's address is not publicly visible, providing further privacy for the receiver.
- Bulletproofs: A cryptographic technique that reduces the size of confidential transactions, making them more efficient while maintaining privacy.
Through these features, Monero ensures that transactions remain private and untraceable, preventing third parties from linking transactions to specific users.
The Monero blockchain is public and permissionless, but with a primary focus on privacy and confidentiality. Unlike other cryptocurrencies, Monero keeps transaction details hidden (sender, recipient, and amounts), making it the preferred choice for those seeking enhanced privacy in their digital transactions.

- **Market Position:** Monero is the leading privacy coin, maintaining a strong presence in markets where confidentiality is paramount.
- **Significance:** Monero's focus on privacy and fungibility distinguishes it from other cryptocurrencies, catering to users seeking secure and untraceable transactions.

5. **Aave (AAVE-USD)**

- **Description:** Aave is a decentralized finance (DeFi) protocol launched in 2020, enabling users to lend and borrow a variety of cryptocurrencies without intermediaries. It operates on Ethereum and other blockchains and is one of the leading platforms in the decentralized finance (DeFi) space.
Since Aave operates primarily on Ethereum, it uses Ethereum's PoS consensus mechanism. Aave facilitates liquidity pools where users can lend their tokens to earn interest, while borrowers can access liquidity by collateralizing assets. Aave also introduces features like flash loans, where users can borrow assets without collateral, provided the loan is repaid within the same transaction.
Aave ensures the safety of funds through decentralized governance, smart contract auditing, and over-collateralization for loans. Aave operates on Ethereum and supports other blockchains like Polygon, Avalanche, and Fantom for cross-chain liquidity.
- **Market Position:** Aave is one of the top DeFi platforms by total value locked (TVL), recognized for its innovative features like flash loans and aTokens.
- **Significance:** Aave plays a crucial role in the DeFi ecosystem, providing liquidity solutions and fostering financial inclusion through decentralized lending and borrowing services.

1.2.3 Summary of Consensus Mechanisms and Protocols

Table 2: Cryptocurrency Overview

Cryptocurrency	Consensus Mechanism	Blockchain Type	Key Features
Bitcoin (BTC)	Proof of Work (PoW)	Public, permissionless	Decentralized, secure, limited supply
Ethereum (ETH)	Proof of Stake (PoS)	Public, permissionless	Smart contracts, decentralized apps
Dai (DAI)	Algorithmic (via MakerDAO)	Public (ERC-20 token)	Decentralized stablecoin, overcollateralization
Monero (XMR)	Proof of Work (PoW, RandomX)	Public, permissionless	Privacy-focused, untraceable transactions
Aave (AAVE)	Proof of Stake (PoS, via Ethereum)	Public (on Ethereum, others)	Decentralized lending, flash loans

1.2.4 Rationale for Selection

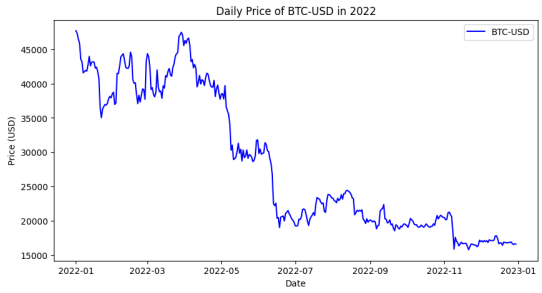
Our group chose these five cryptocurrencies based on the following criteria:

- **Diversity in Protocols:** The selected cryptocurrencies utilize a range of consensus and operational protocols, including PoW, PoS, and proprietary systems like MakerDAO's CDPs. This diversity ensures a comprehensive analysis across different technological foundations.
- **Market Capitalization and Liquidity:** These assets represent a significant portion of the total cryptocurrency market capitalization, providing ample liquidity and robust trading volumes for meaningful statistical analysis.
- **Technological Innovations and Use Cases:** Each cryptocurrency showcases unique technological advancements and serves distinct use cases—from Bitcoin's store of value to Aave's DeFi lending protocols—highlighting the versatility within the crypto ecosystem.
- **Representation of Different Blockchain Ecosystems:** The selection covers a variety of blockchain platforms and ecosystems, including Bitcoin's blockchain, Ethereum's smart contract platform, and Monero's privacy-centric network, offering insights into their interlinkages and comparative performance.

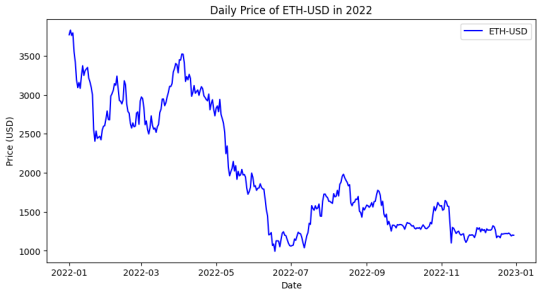
1.3 Plotting Daily Prices

Using the cryptocurrency data from Yahoo Finance for the period from January 1, 2022, to December 31, 2022, we plotted the daily prices for the five selected cryptocurrencies. Depending

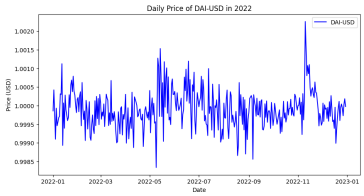
on their comparative price levels, we present the plots in both individual and combined formats for better visualization.



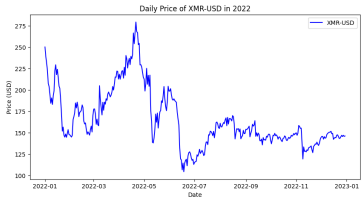
(a) Bitcoin (BTC-USD)



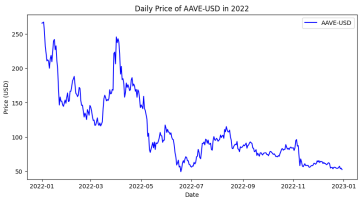
(b) Ethereum (ETH-USD)



(c) Dai (DAI-USD)



(d) Monero (XMR-USD)



(e) Aave (AAVE-USD)

Figure 1: Daily Prices of Selected Cryptocurrencies (2022)

Additionally, to provide an overall comparison, we included a combined plot of the daily prices:

1.4 Price Trends Analysis

The plots in Figure 1 and Figure 9 illustrate the daily price movements of the selected cryptocurrencies over the year 2022. The following observations can be made from the price variations:

1. **Bitcoin (BTC-USD):** As the primary cryptocurrency, Bitcoin often leads market trends. Significant growth periods may coincide with increased institutional adoption or halving events, while declines can be triggered by regulatory news or macroeconomic instability.

2. **Ethereum (ETH-USD):** Ethereum's price movements are closely tied to the development of DeFi and NFT sectors, as well as major upgrades like the Merge. Positive trends may reflect successful deployment of scaling solutions or increased usage of smart contracts.

3. **Dai (DAI-USD):** Being a stablecoin, Dai typically maintains a stable price around $1. Deviations can indicate issues with the collateral backing or market demand for stable assets amid volatility.

4. **Monero (XMR-USD):** Monero's price fluctuations are influenced by shifts in privacy regulations, enhancements in privacy technologies, and adoption rates in privacy-sensitive applications.

Figure 2: Combined Daily Prices of Selected Cryptocurrencies (2022)

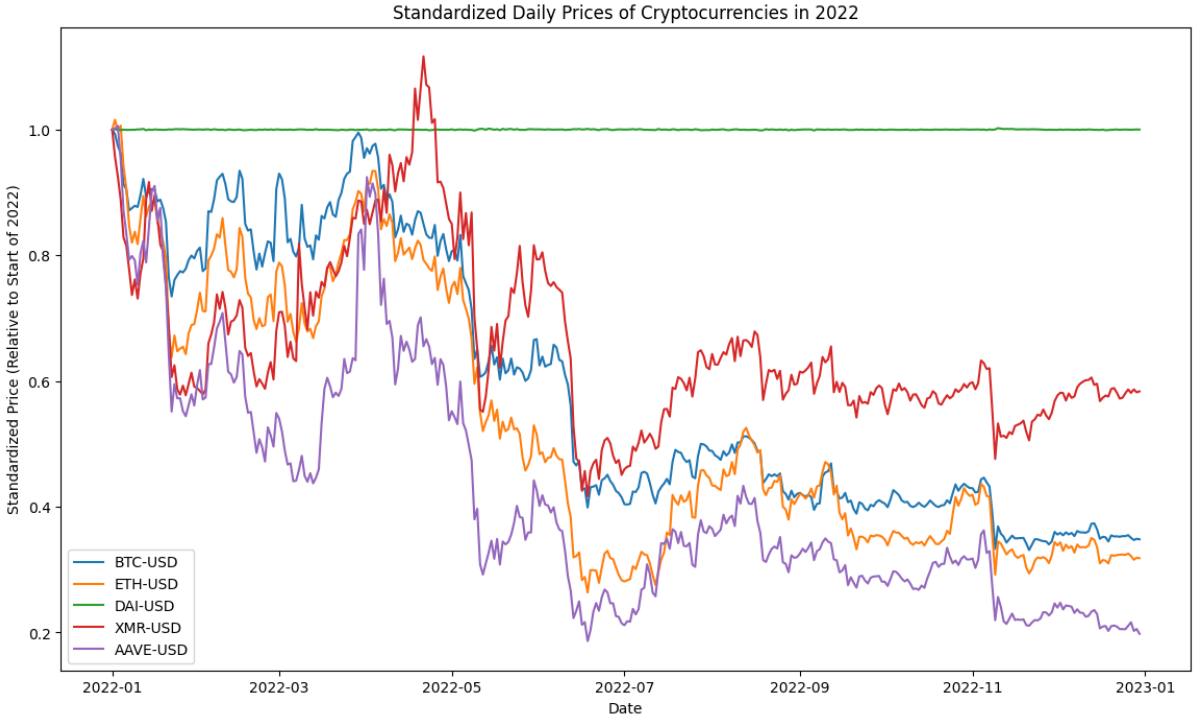


Figure 3: Standardized Daily Prices of Cryptocurrencies in 2022

5. **Aave (AAVE-USD):** Aave's price is influenced by the growth of the DeFi sector, changes in lending and borrowing volumes, and the introduction of new features or integrations within its protocol.

1.5 Daily Returns and Standard Deviations

To assess the volatility of the selected cryptocurrencies, we computed their daily returns and calculated the standard deviations over the sample period.

1.5.1 Calculations

Figure 4 presents the daily log returns of the selected cryptocurrencies for the year 2022.

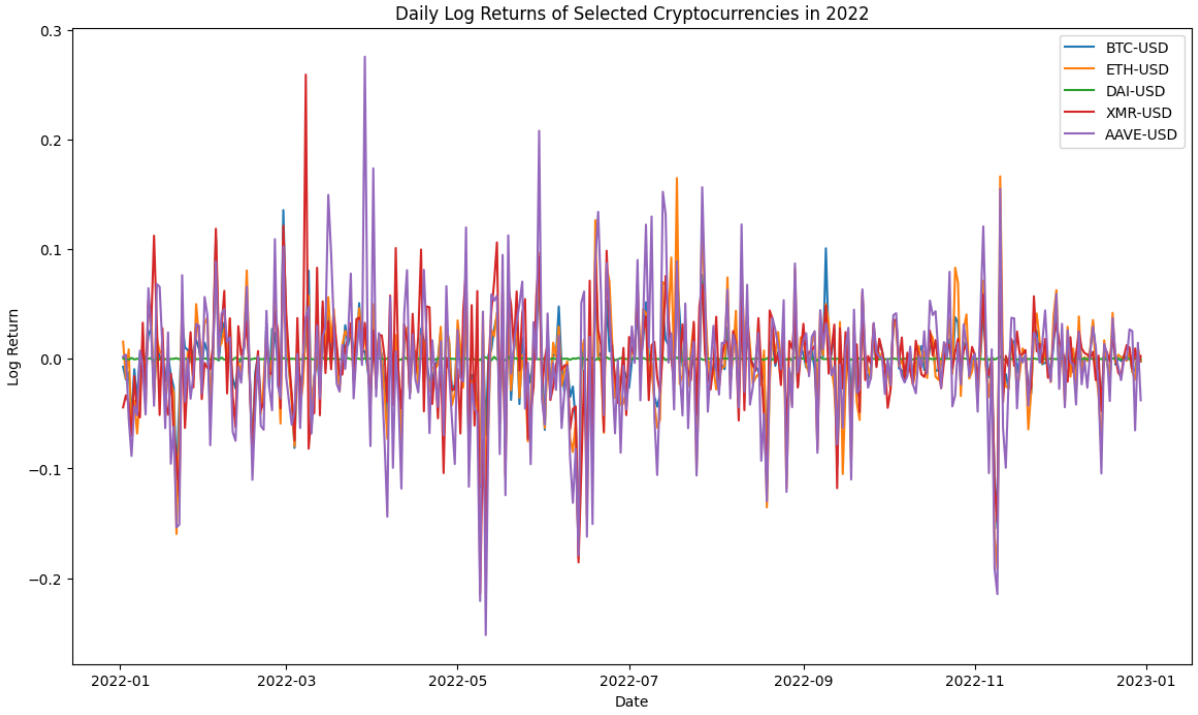


Figure 4: Daily Log Returns of Selected Cryptocurrencies (2022)

1.5.2 Standard Deviations of Daily Log Returns

The standard deviations of the daily log returns are summarized in Table 3.

Table 3: Standard Deviations of Daily Log Returns

Ticker	Standard Deviation
BTC-USD	0.0337
ETH-USD	0.0457
DAI-USD	0.0006
XMR-USD	0.0472
AAVE-USD	**0.0635**

Highest Volatility: AAVE-USD (0.0635)
Lowest Volatility: DAI-USD (0.0006)
Note: The standard deviations are calculated based on daily log returns from January 1, 2022, to December 31, 2022. The values are rounded to four decimal places for clarity.

1.5.3 Analysis

Identifying Highest and Lowest Variation

From Table 3, it is evident that **AAVE-USD** exhibits the highest standard deviation of daily log returns (0.0635), indicating the greatest variation and volatility among the selected cryptocurrencies. Conversely, **DAI-USD** has the lowest standard deviation (0.0006), demonstrating minimal variation and stability within the sample period.

Explaining Differences in Variation

1. Market Volatility:

- **AAVE-USD**: As a prominent player in the decentralized finance (DeFi) sector, Aave is subject to higher market volatility due to its involvement in lending, borrowing, and the issuance of various DeFi products. The rapid innovation and frequent updates in the DeFi space can lead to swift price fluctuations as investors react to new developments, protocol upgrades, or shifts in market sentiment.
- **DAI-USD**: Being a stablecoin pegged to the US Dollar, Dai is designed to maintain price stability. Its minimal standard deviation reflects its underlying mechanism, which involves collateralized debt positions (CDPs) and over-collateralization to absorb market volatility. This design ensures that Dai remains close to its peg, reducing the price fluctuations typically observed in other cryptocurrencies.

2. Adoption Rates:

- **AAVE-USD**: Higher adoption rates in the DeFi ecosystem contribute to increased trading volume and liquidity, which can amplify price movements. As more users engage with Aave's lending and borrowing protocols, the demand and supply dynamics can lead to greater price instability, especially during periods of market stress or speculative trading.
- **DAI-USD**: Dai's adoption is primarily driven by its role as a stable medium of exchange and collateral in DeFi applications. Its function as a stablecoin invulnerable to the whims of speculative trading reduces the likelihood of significant price swings, maintaining its stability regardless of broader market trends.

3. Inherent Technology:

- **AAVE-USD**: Aave operates on the Ethereum blockchain, leveraging smart contracts to facilitate its DeFi services. The complexity and dynamism of these smart contracts, along with the potential for protocol-dependent risks, contribute to the inherent volatility of Aave's token price. Any technical vulnerabilities, smart contract upgrades, or changes in DeFi regulations can directly impact its market performance.
- **DAI-USD**: Dai's stability is reinforced by its robust smart contract design within the MakerDAO ecosystem. The use of over-collateralization and decentralized governance mechanisms ensures that Dai can adapt to market conditions without compromising its peg. The inherent technology focuses on maintaining stability and resilience, which inherently limits price variation.

4. Use Cases and Ecosystem Role:

- **AAVE-USD**: As a utility token within the Aave protocol, AAVE is integral to various DeFi operations, including governance (voting on proposals) and liquidity provision. Its

multifaceted use cases facilitate active trading and engagement, which can lead to higher volatility as users and investors respond to protocol developments and DeFi market conditions.

- **DAI-USD**: Dai's primary use case as a stablecoin for facilitating transactions, acting as collateral, and enabling yield farming ensures that its primary function remains stable. Its role does not entail speculative investment, thereby minimizing factors that could lead to high volatility.

5. External Influences:

- **AAVE-USD**: External factors such as regulatory changes, macroeconomic events, and shifts in investor sentiment towards DeFi can significantly influence Aave's price volatility. For instance, announcements regarding DeFi regulations or systemic DeFi risks can lead to rapid price changes.
- **DAI-USD**: Dai is less susceptible to external speculative pressures due to its stablecoin nature. However, it can still be influenced by factors like the overall health of the cryptocurrency market, the effectiveness of its collateralization mechanisms, and the governance decisions within MakerDAO.

Conclusion

The differential volatility between AAVE-USD and DAI-USD highlights the contrasting mechanisms and roles these cryptocurrencies play within the ecosystem. While Aave's integration in the DeFi space exposes it to higher fluctuations, Dai's stablecoin design ensures its price remains anchored, providing stability amid market turbulence.

1.6 Correlation Matrix

To understand the interlinkages among the selected cryptocurrencies, we generated a correlation matrix using the daily returns of the five cryptocurrencies. The correlation matrix is presented in Table 4.

Table 4: Correlation Matrix of Selected Cryptocurrencies

Ticker	BTC-USD	ETH-USD	DAI-USD	XMR-USD	AAVE-USD
BTC-USD	1.000000	0.899437	0.226203	0.711921	0.780396
ETH-USD	0.899437	1.000000	0.220118	0.700842	0.821226
DAI-USD	0.226203	0.220118	1.000000	0.191756	0.240567
XMR-USD	0.711921	0.700842	0.191756	1.000000	0.661512
AAVE-USD	0.780396	0.821226	0.240567	0.661512	1.000000

Figure 5 displays a heatmap representation of the correlation matrix, providing a visual overview of the strength and direction of the relationships between the cryptocurrencies.

Conclusion from Correlation Matrix Strength and Direction of Correlations

The correlation matrix in Table 4 reveals the relationships between the daily log returns of Bitcoin (BTC-USD), Ethereum (ETH-USD), Dai (DAI-USD), Monero (XMR-USD), and Aave

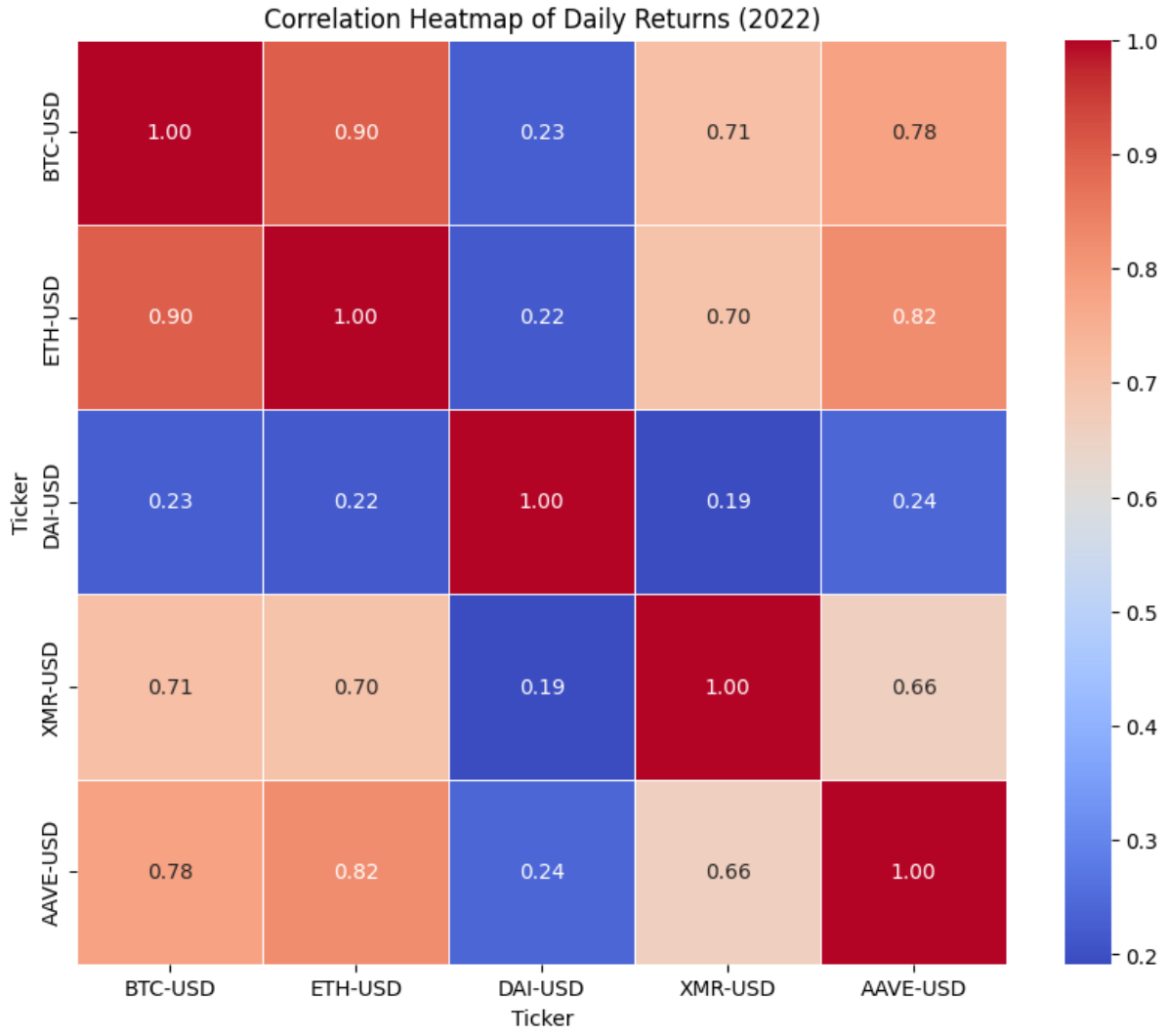


Figure 5: Correlation Heatmap of Daily Returns of Selected Cryptocurrencies

(AAVE-USD). The correlation coefficients range from low to very high positive values, indicating varying degrees of synchronized price movements among the selected cryptocurrencies.

Highly Correlated Pairs

- **BTC-USD and ETH-USD (Correlation: 0.8994):** The correlation between Bitcoin and Ethereum is very high, suggesting that these two leading cryptocurrencies often experience simultaneous price movements. This strong positive correlation can be attributed to their dominant positions in the market, widespread adoption, and the fact that Ethereum's market performance is often influenced by Bitcoin's price trends.
- **ETH-USD and AAVE-USD (Correlation: 0.8212):** Ethereum and Aave also exhibit a very high correlation. As Aave operates on the Ethereum blockchain, its performance is closely tied to Ethereum's stability and growth. Increased usage of Ethereum for DeFi applications likely drives the demand for Aave, resulting in correlated price movements.
- **BTC-USD and AAVE-USD (Correlation: 0.7804):** Bitcoin and Aave show a strong positive correlation, reflecting Bitcoin's influence as the market leader. Fluctuations in Bitcoin's price can have spillover effects on other cryptocurrencies, including Aave, due to investor sentiment and capital flow dynamics within the crypto market.
- **BTC-USD and XMR-USD (Correlation: 0.7119):** Bitcoin and Monero have a moderately high positive correlation. While Monero focuses on privacy and fungibility, it still shares Bitcoin's foundational technology and benefits from Bitcoin's overall market sentiment, leading to correlated performance.
- **ETH-USD and XMR-USD (Correlation: 0.7008):** Ethereum and Monero also display a strong positive relationship. The usage of Ethereum for deploying smart contracts and Monero's role in privacy-focused transactions both cater to niche yet overlapping segments of the cryptocurrency ecosystem.

Analysis of Correlation Strength and Implications

The high positive correlations between major cryptocurrencies like Bitcoin and Ethereum suggest that market movements are often influenced by broader market sentiments rather than isolated factors. This interconnectedness implies that significant macroeconomic events, regulatory news, or technological advancements impacting one major cryptocurrency are likely to reverberate across the other major players.

Potential Reasons for Correlations

- **Same Underlying Protocols:** Ethereum-based cryptocurrencies like Aave inherently rely on the Ethereum network for their operations. This dependency means that advancements, upgrades, or issues within Ethereum directly affect these tokens, resulting in strong correlations.
- **Market Influences:** The cryptocurrency market is often influenced by overall investor sentiment, regulatory developments, and macroeconomic factors. When Bitcoin, as the leading cryptocurrency, experiences price movements due to such influences, other cryptocurrencies tend to follow suit.

- **Liquidity and Trading Pairs:** Many cryptocurrencies are traded against Bitcoin and Ethereum, making them susceptible to the price movements of these major coins. High liquidity in BTC and ETH markets facilitates swift capital flow between these and other cryptocurrencies, reinforcing correlations.
- **Technological Developments:** Innovations or setbacks in technology, such as Ethereum's transition to Proof of Stake (PoS), can create industry-wide impacts that resonate across multiple cryptocurrencies on the same or interconnected platforms.
- **Investment Portfolios:** Institutional and retail investors often include multiple cryptocurrencies in their portfolios. Diversified investments in BTC, ETH, and DeFi tokens like Aave amplify the correlated asset movements as portfolio rebalancing or margin trading occurs.

Conclusion

The correlation analysis underscores the highly interconnected nature of the cryptocurrency market, particularly among leading tokens like Bitcoin and Ethereum. While Aave and Monero exhibit strong correlations with these giants, Dai stands out with its minimal correlation, reflecting its stablecoin nature designed to maintain price stability irrespective of market turbulence. Understanding these relationships is crucial for investors aiming to diversify their portfolios and manage risk effectively within the volatile cryptocurrency landscape.

1.7 Impact of FTX Failure (Mid-November 2022)

In mid-November 2022, the cryptocurrency market experienced a significant upheaval due to the collapse of FTX. Specifically, on November 11, FTX filed for bankruptcy, and its CEO, Sam Bankman-Fried, stepped down. This event had a profound impact on the broader cryptocurrency market, affecting various digital assets to differing extents.

Analysis of Price Movements on November 11, 2022

To assess the immediate impact of FTX's failure, we examined the price movements of five major cryptocurrencies on November 11, 2022. The analysis focused on the percentage change in their prices on that specific day.

Table 5: Percentage Change of Cryptocurrencies on November 11, 2022

Ticker	**Percentage Change (%)**
BTC-USD	-3.1414%
ETH-USD	-0.9422%
DAI-USD	-0.0703%
XMR-USD	-3.9068%
AAVE-USD	-6.0765%

From Table 5, we observe that:

- **Aave (AAVE-USD)** exhibited the highest volatility with a -6.0765% decrease.
- **Dai (DAI-USD)** showed the lowest volatility, decreasing by only -0.0703%.

Broader Impact Throughout November 2022

Extending the analysis to encompass the entire month of November 2022 provides a more comprehensive view of FTX's impact on the cryptocurrency market. The cumulative percentage changes over the month highlight the sustained effects beyond the immediate aftermath of the bankruptcy filing.

Table 6: Total Percentage Change of Cryptocurrencies in November 2022

Ticker	Total Percentage Change (%)
BTC-USD	−16.1907%
ETH-USD	−17.9791%
DAI-USD	−0.0522%
XMR-USD	−5.0430%
AAVE-USD	−22.5158%

During November:

- **Aave (AAVE-USD)** again showed the highest volatility with a −22.5158% decrease.
- **Dai (DAI-USD)** remained the least volatile asset, with a −0.0522% change.

Summary of Volatility

- **Highest Volatility on November 11, 2022: AAVE-USD** (−6.0765%)
- **Lowest Volatility on November 11, 2022: DAI-USD** (−0.0703%)
- **Highest Volatility in November 2022: AAVE-USD** (−22.5158%)
- **Lowest Volatility in November 2022: DAI-USD** (−0.0522%)

Note: The percentage changes are calculated based on daily log returns from January 1, 2022, to December 31, 2022.

Discussion

The analysis reveals a differential impact of the FTX failure across the selected cryptocurrencies:

- **Aave (AAVE-USD)** faced the most significant decline both on the day of the bankruptcy filing and over the entire month of November. This heightened sensitivity may be attributed to Aave's close ties within the decentralized finance (DeFi) ecosystem, which could have been directly affected by FTX's collapse.
- **Bitcoin (BTC-USD)** and **Ethereum (ETH-USD)** experienced substantial decreases, reflecting their status as major market players. Their larger market capitalizations mean that significant events like the FTX failure can trigger broader market sentiments affecting major cryptocurrencies.
- **Monero (XMR-USD)** also saw notable declines, possibly due to its position in the privacy-focused segment of the market, which may have been impacted by increased regulatory scrutiny following the FTX incident.

- **Dai (DAI-USD)**, being a stablecoin, exhibited minimal volatility. Its design to maintain a stable value likely insulated it from the market-wide downturn triggered by FTX's failure.

The varying degrees of impact underscore the importance of market dynamics and the extent of each cryptocurrency's exposure to centralized platforms like FTX. Coins with deeper integration into the broader financial ecosystem or those relying on liquidity from exchanges may be more susceptible to such systemic shocks.

1.8 Inclusion of S&P 500 Index (ĜSPC)

To provide a comprehensive analysis, we included the S&P 500 Index (ĜSPC) from Yahoo Finance in our study. This inclusion allows us to compare the performance of cryptocurrencies with a traditional financial market index, offering insights into their relative behaviors and interlinkages.

Table 7: Summary Statistics for S&P 500 Index (ĜSPC)

Ticker	**ĜSPC**
count	362.0000
mean	4097.5575
std	289.8925
min	3577.0300
25%	3873.3301
50%	4057.6599
75%	4348.8701
max	4796.5601

1.8.1 Market Index Calculations

- **Compute Daily Prices and Daily Returns:** We extracted the daily closing prices of the S&P 500 Index (ĜSPC) for the period from January 1, 2022, to December 31, 2022. Daily returns were calculated using the logarithmic return formula:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

  where P_t is the closing price on day t, and R_t is the return on day t.

- **Calculate the Standard Deviation of Daily Returns:** The standard deviation provides a measure of the index's volatility over the sample period.

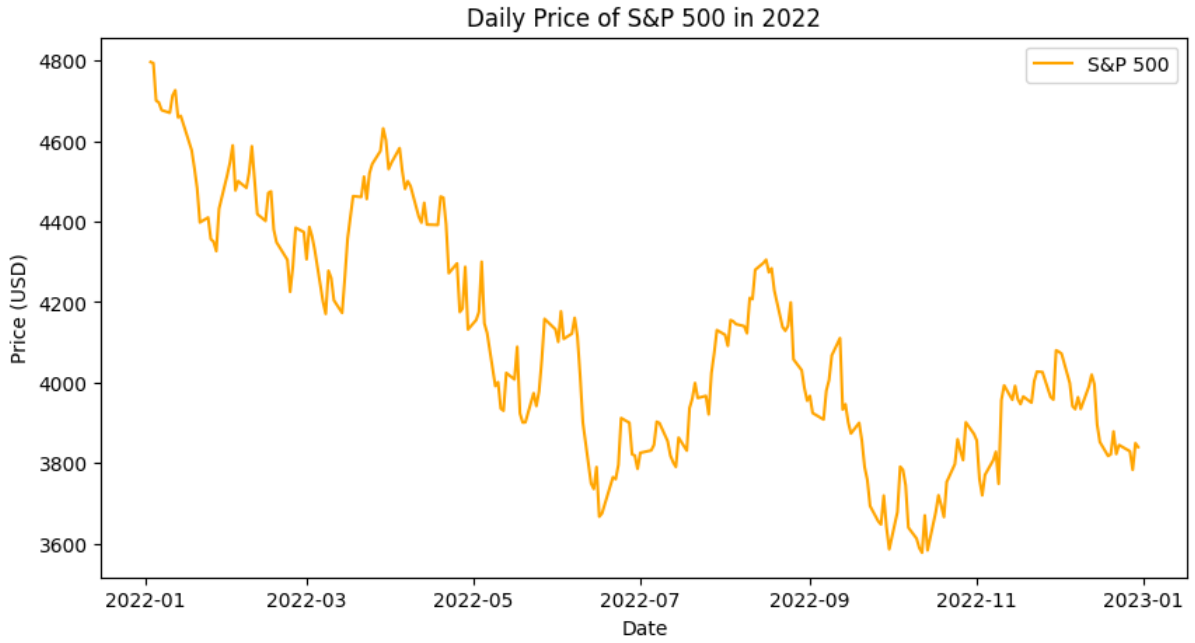


Figure 6: Daily Prices of S&P 500 Index ($\hat{\text{G}}$SPC) (2022)

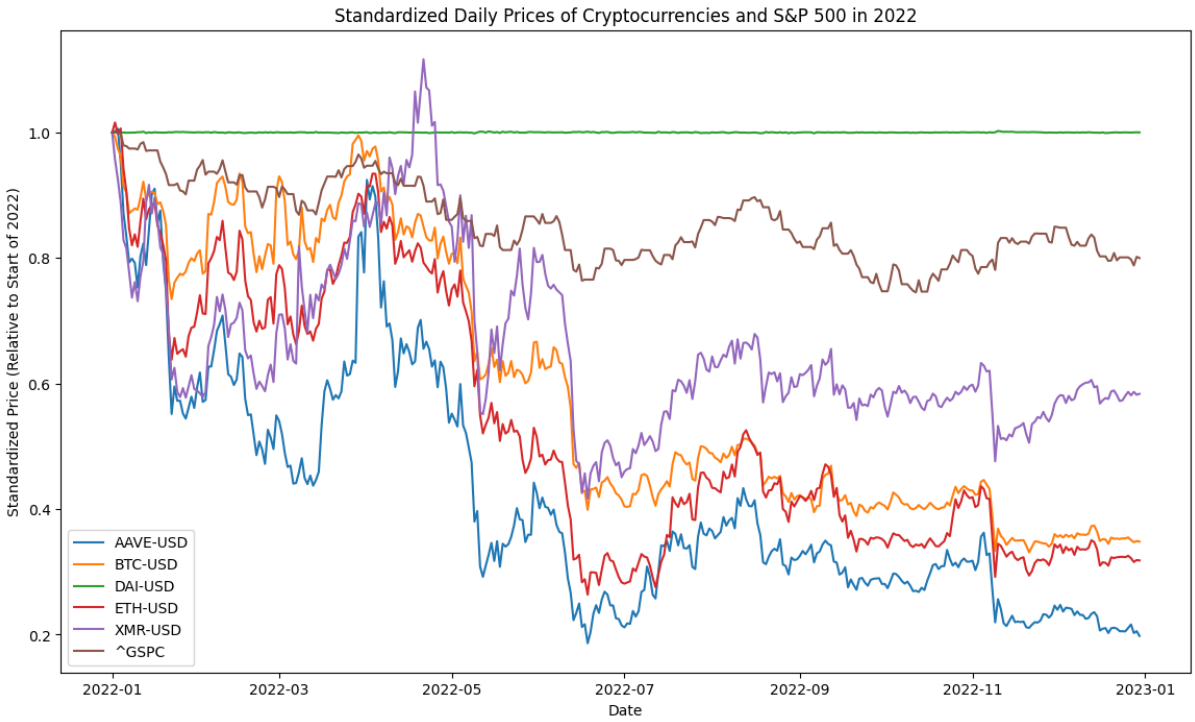


Figure 7: Standardized Daily Prices of Cryptocurrencies and S&P 500 in 2022

1.8.2 Correlation Matrix with Market Index

We recomputed the correlation matrix by including the S&P 500 Index (ĜSPC) alongside the five selected cryptocurrencies. This allows us to evaluate the relationship between digital assets and traditional financial markets.

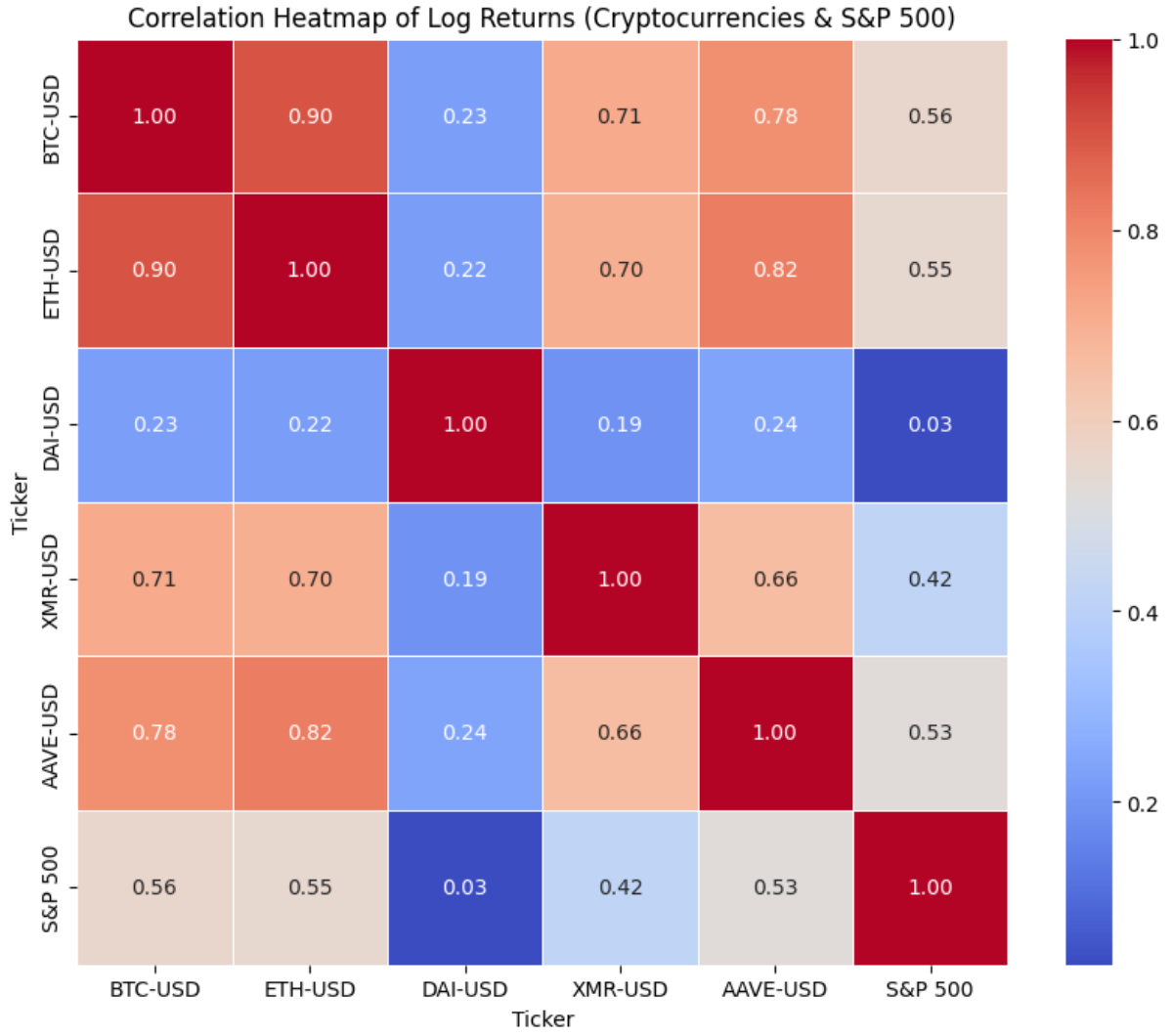


Figure 8: Correlation Heatmap of Selected Cryptocurrencies and S&P 500 Index (ĜSPC) (2022)

1.8.3 Comparative Analysis

Comparison of Daily Prices, Daily Returns, and Standard Deviations

Table 8 presents a comparison of the standard deviations of daily log returns between the five cryptocurrencies and the S&P 500 Index (ĜSPC).

Discussion of Volatility and Return Patterns

- **Volatility Comparison:** The S&P 500 Index (ĜSPC) exhibits significantly lower volatility (Standard Deviation: 0.0153) compared to the selected cryptocurrencies. Among

Table 8: Comparison of Standard Deviations of Log Returns (Volatility)

Category	Ticker	Standard Deviation
S&P 500	ĜSPC	0.0153
Cryptocurrencies	BTC-USD	0.0337
	ETH-USD	0.0457
	DAI-USD	0.0006
	XMR-USD	0.0472
	AAVE-USD	0.0635

the cryptocurrencies, Aave (AAVE-USD) shows the highest volatility (0.0635), while Dai (DAI-USD) remains the least volatile (0.0006), consistent with its stablecoin nature.

- **Return Patterns:** Cryptocurrencies, in general, display higher returns volatility compared to the S&P 500. This indicates that digital assets are more susceptible to rapid price changes, making them riskier but potentially more rewarding investments.
- **Implications for Investors:** The stark difference in volatility suggests that cryptocurrencies can offer diversification benefits when included in a traditional investment portfolio. While they introduce higher risk, their low or variable correlation with the S&P 500 can potentially enhance the risk-return profile of the portfolio.

1.8.4 Conclusion from Including S&P 500 Index

- **Relationship Between Cryptocurrency Performance and Traditional Financial Markets:** The inclusion of the S&P 500 Index (ĜSPC) highlights that cryptocurrencies and traditional financial markets exhibit differing volatility profiles. While traditional markets like the S&P 500 offer stability, cryptocurrencies provide higher returns albeit with increased risk.
- **Independence vs. Correlation:** The correlation matrix indicates that major cryptocurrencies such as Bitcoin and Ethereum have strong positive correlations with each other but relatively lower or negligible correlations with the S&P 500 Index. This suggests that, to some extent, cryptocurrencies behave independently of traditional stock markets.
- **Portfolio Diversification Implications:** Given their low correlation with traditional financial assets, including cryptocurrencies in an investment portfolio can enhance diversification. This diversification can potentially reduce overall portfolio risk and improve returns, especially during periods when traditional markets underperform.
- **Risk Management Considerations:** Investors need to balance the high-risk, high-return nature of cryptocurrencies with the more stable returns from traditional assets. Understanding the volatility and correlation dynamics is crucial for effective portfolio construction and risk management.

1.8.5 Reaction to FTX Failure

Analyzing the reaction of the S&P 500 Index (ĜSPC) and the selected cryptocurrencies to the FTX failure provides insights into their sensitivity to external shocks.

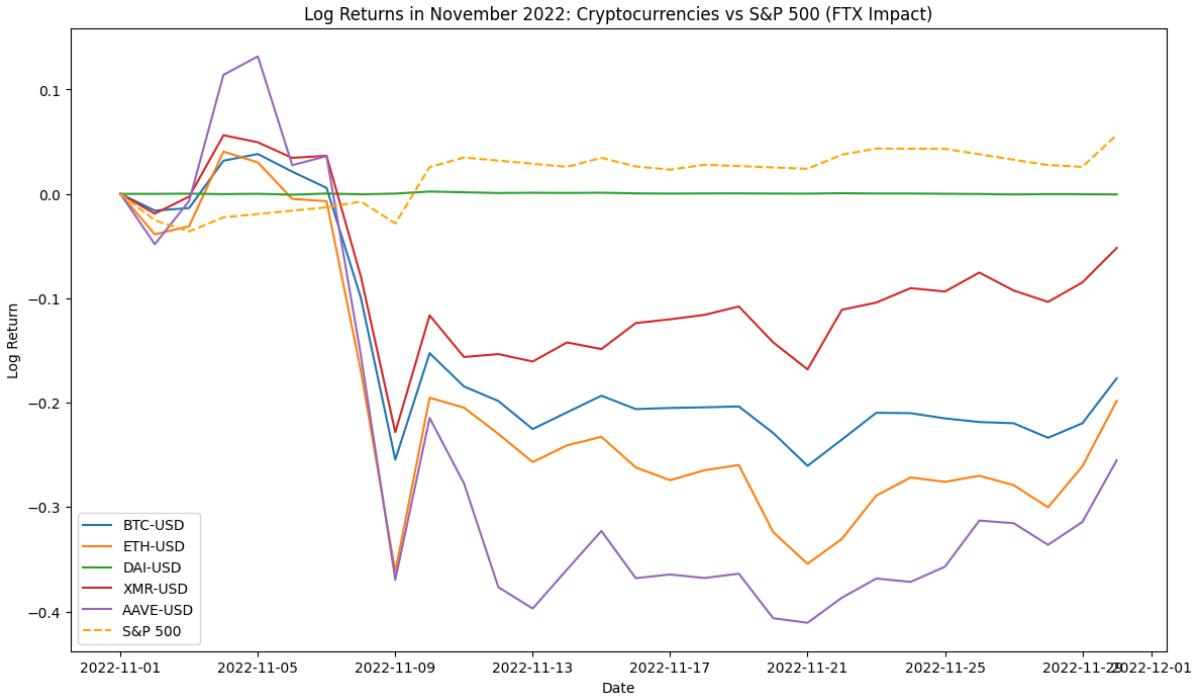


Figure 9: Log Returns in November 2022: Cryptocurrencies vs S&P 500 (FTX Impact) (2022)

- **Market Index (ĜSPC):** The S&P 500 Index, being a traditional financial market indicator, may experience indirect effects from significant cryptocurrency market events. However, its reaction is typically less pronounced unless the event has broad economic implications.
- **Cryptocurrencies:** As observed earlier, cryptocurrencies like Aave (AAVE-USD) experienced substantial declines during the FTX failure. This indicates a higher sensitivity to industry-specific events, especially those involving centralized exchanges, which play a pivotal role in crypto trading ecosystems.
- **Comparison:** The S&P 500 Index may show modest declines or remain relatively stable during such events, whereas cryptocurrencies can exhibit sharp price movements. This contrast underscores the distinct factors influencing traditional and digital asset markets.

1.9 Lessons Learned from Part I

- **Volatility Characteristics:** Cryptocurrencies exhibit significantly higher volatility compared to traditional financial markets like the S&P 500 Index. Understanding this volatility is crucial for investors considering digital assets in their portfolios.
- **Influence of External Events:** The collapse of major platforms like FTX can have a

pronounced impact on cryptocurrency prices, highlighting the interconnectedness within the crypto ecosystem and the potential risks associated with centralized entities.

- **Correlation Insights:** While major cryptocurrencies like Bitcoin and Ethereum are highly correlated with each other, their relationships with traditional financial indices like the S&P 500 are relatively weaker. This suggests that cryptocurrencies can serve as a means of diversification in investment strategies.
- **Stablecoins as Stabilizers:** Dai (DAI-USD), as a stablecoin, demonstrates minimal volatility, serving as a stabilizing force within the crypto market. This role is essential for users seeking to mitigate exposure to price fluctuations.
- **Impact on Portfolio Diversification:** Incorporating cryptocurrencies alongside traditional assets can potentially enhance portfolio diversification, offering avenues for higher returns while balancing overall risk.
- **Market Dynamics Understanding:** An in-depth analysis of market dynamics, including the influence of DeFi protocols and the role of liquidity, is vital for comprehending the behavior of various digital assets.
- **Risk Management Strategies:** Effective risk management in crypto investments involves considering the unique risk factors inherent to digital assets, such as technological vulnerabilities, regulatory changes, and market sentiment shifts.

2 Part II: A Business Idea to be Implemented on the Blockchain

2.1 Introduction

Blockchain technology has revolutionized various industries by introducing decentralization, transparency, and security. Our proposed platform leverages these strengths to offer decentralized intellectual property (IP) management for creators and innovators. This document outlines our business idea, target consumers, competitive landscape, unique value propositions, implementation strategy on the Ethereum blockchain, and economic viability.

2.2 Target Consumers

Our platform caters to a diverse group of independent creators and enterprises seeking secure and decentralized IP management solutions. The primary target consumers include:

- **Independent Artists and Musicians:** Artists seeking to tokenize their works as NFTs for proof of ownership and rights management.
- **Software Developers and Researchers:** Innovators needing secure IP management for their software, patents, and academic research.
- **Enterprises and Investors:** Organizations and individuals looking to access verified IP assets for licensing, collaboration, or investment opportunities.

2.3 Closest Existing Competitors

Our platform operates in a competitive landscape with several notable players:

- **Async Art:** Specializes in tokenizing and licensing digital art with programmable NFTs, enabling creators to set dynamic rules.
- **Audius:** A decentralized music-sharing protocol that rewards creators with tokens and ensures transparent royalty distribution.
- **Kadena IP Marketplace:** Focuses on managing patents and IP rights on the blockchain, offering a decentralized trading and licensing platform.

2.4 Competitive Advantage

Our platform differentiates itself through several unique features:

- **Reputation-Based System:** Utilizes a dynamic reputation system based on user activity and feedback, fostering trust and ensuring fair visibility and rewards.
- **Royalty Automation:** Smart contracts that automatically enforce royalty payments, ensuring creators are paid fairly and promptly.
- **Dispute Resolution:** On-chain arbitration mechanisms provide transparent and fair resolution of IP disputes.

- **Cross-Industry Integration:** Supports diverse creative domains, including music, visual arts, patents, and academic works, unlike competitors focused on specific niches.
- **Enhanced Discovery:** Community-driven ratings and reputation scores facilitate the discovery of credible and high-quality IP assets by enterprises and investors.

2.5 Rationale for Blockchain Deployment

Deploying our platform on the blockchain offers significant advantages over centralized systems:

- **Immutability and Security:** Ensures a tamper-proof ledger of IP ownership and rights, reducing the risk of disputes or fraud.
- **Transparency:** Publicly auditable licensing and royalty transactions foster trust between creators and users.
- **Global Accessibility:** Removes geographical barriers, enabling global collaboration and access to IP assets.
- **Smart Contract Automation:** Eliminates intermediaries, reducing costs and ensuring timely royalty payments.

2.6 Implementation on the Ethereum Blockchain

Technical Framework:

1. **Tokenization of IP Assets:** Intellectual property is tokenized as NFTs, with metadata securely stored on-chain or via decentralized storage solutions like IPFS.
2. **Smart Contracts:** Developed in Solidity to handle IP ownership, licensing, royalty distribution, and dispute resolution.
3. **Reputation Scoring:** An on-chain dynamic reputation system based on user activity, feedback, and verified contributions.
4. **Oracles:** Integration with oracles like Chainlink to fetch external data (e.g., copyright registrations) for claim verification and compliance.
5. **DAO for Governance:** A decentralized autonomous organization allowing users to participate in governance, including voting on platform policies and dispute resolutions.
6. **User Interface:** A user-friendly interface enabling creators to tokenize their work, manage royalties, and interact with the community.

Technical Hurdles and Solutions:

- **Scalability and Gas Fees:** High transaction fees on Ethereum can be mitigated by utilizing layer-2 solutions like Arbitrum or Optimism.
- **Data Privacy:** Implementing privacy-preserving technologies such as zk-SNARKs or confidential contracts to protect sensitive information.

- **Integration with Oracles:** Ensuring reliable oracle integration for accurate external data fetching, crucial for claims and licensing validation.

2.7 Economic Viability on Ethereum

Cost-Benefit Analysis:

- While Ethereum offers robust security and a large developer community, high gas fees can be a deterrent for small creators. However, deploying on layer-2 solutions and optimizing smart contract efficiency can alleviate these concerns.

Revenue Streams:

- **Transaction Fees:** Charges on tokenization, trading, and licensing transactions.
- **Licensing Agreements:** Fees from facilitating licensing deals between IP owners and licensees.
- **Premium Services:** Optional services such as enhanced IP verification and legal consulting for additional fees.

Market Size and Demand:

- The growing adoption of NFTs and decentralized solutions among content creators indicates significant market potential. The total market capitalization of over $800 billion across more than 21,000 coins/tokens underscores the expansive growth in the cryptocurrency industry.

2.8 Economic Viability on Other Blockchains

Alternative Platforms:

- **Polygon, Solana, Tezos:** These platforms offer lower fees and faster transactions, making them attractive alternatives for cost-sensitive users.

Interoperability:

- Building cross-chain compatibility allows creators to tokenize and manage IP across multiple blockchain ecosystems, enhancing flexibility and user reach.

Custom Blockchain:

- For enterprise-specific use cases, developing a tailored blockchain with optimized features for IP management could be a viable option, providing enhanced customization and control over platform functionalities.

Conclusion: Our platform leverages blockchain's core strengths to disrupt traditional IP management systems by empowering creators through decentralization, ensuring transparency, fairness, and security. With strategic technical implementations and economic considerations, the platform is poised for widespread adoption and long-term sustainability.

2.9 Conclusion

The proposed decentralized IP management platform addresses the critical needs of modern creators and enterprises by providing a secure, transparent, and efficient solution for IP tokenization and management. By utilizing the Ethereum blockchain and incorporating a reputation-based system, smart contract automation, and cross-industry integration, the platform stands out in the competitive landscape. Strategic considerations regarding scalability, data privacy, and economic viability further reinforce the platform's potential for success in the evolving financial technology landscape.