

# THE CHALLENGES AND OPPORTUNITIES OF BLOCKCHAIN IN FINANCIAL SYSTEMS: A DEEP DIVE INTO DECENTRALIZED FINANCE (DeFi): ITS IMPACT ON TRADITIONAL BANKING

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#### Abstract

The subject of discussion has become the effects of the blockchain and decentralized finance (DeFi) on conventional banking, as well as the perspectives and threats of such solutions. The study explores the impact, risk-adjusted returns, inequality features, and transaction characteristics of the DeFi platforms with the incumbent banking systems by adopting PageRank analysis, Sharpe ratio evaluation, Gini Index measurement, and K-means clustering. The PageRank analysis revealed that traditional banks generally hold higher influence scores (JPMorgan). Compared to other DeFi platforms such as Uniswap, Curve has a slightly lower cash cow coefficient equal to 0. The result of the Sharpe Ratio analysis revealed that overall DeFi platforms like Uniswap have a Sharpe ratio of 0.60, which is higher than the Sharpe ratio of US Treasury Bonds 0. The Gini Index measurement indicated greater inequality in transaction distribution among DeFi platforms (Compound). Further, there is the fee per transaction charged to the client, which varies, where in the case of PayPal, it is \$0. 45, whereas in traditional banks, it is \$0. According to the K-means clustering, the existing financial behaviors were analyzed, and traditional banks dominated in the aspect of transaction volumes and market capitalization as compared to the DeFi platforms. This research highlights the benefits of blockchain applications and DeFi in improving financial systems while identifying the barriers that people would encounter when applying them, including fluctuation and imbalance. Thus, the conclusion of this research calls for further investigation of the possibilities of the consultation of decentralized systems within the current framework of regular banking.

Keywords: Blockchain, Decentralized Finance (DeFi), Traditional Banking, Sharpe Ratio, PageRank.

# I. INTRODUCTION

The core benefit of blockchain has been centered on its function in the financial industry, most specifically being the initiator of DeFi and threatening the traditional established banking system.

Essentially, it provides a distributed and shared ledger that increases the efficiency and security of financial operations. This study aims to look at the complex interrelationships between blockchain and DeFi, with particular emphasis on how they affect traditional banking industries [1].

Decentralized finance can be defined as a sum of financial products and services using blockchain technology and operating in a system without intermediary elements such as a bank. This way, the DeFi platforms allow direct buying and selling, lending, and borrowing between the participants using smart contracts and distributed ledger systems, often at cheaper or more accessible rates than most of the contemporary financial platforms [2].

The switch of approach might help to bring financial services to a completely new level and make the financial industry more open to everyone. However, the growth of decentralized finance has several drawbacks as well at the same time. These include regulatory risks, risks relating to security, and fluctuations in the market, and these issues are dangerous to both the users and the larger economy [3].





Most of the conventional banks are experiencing challenges of having to embrace these innovations or be forced out of the market by competitors who are always embracing new technologies. The incorporation of blockchain and DeFi in the current financial system requires analysis of its implications on the conventional banking model, the laws governing the industry, and financial system resilience.

This research aims to reveal the opportunities and risks that correspond to the application of blockchain and DeFi in financial systems and their impact on traditional banking. Through analyzing such developments, we strive to unveil the potential for further evolution of financial services and directions for enhanced justice and efficiency in the sphere.

# **II. RELATED WORKS**

The first specific topic of interest for the application of blockchain is in the area of financial reporting and accounting. Dashkevich et al. (2024 investigate how, and to what extent, blockchain can revolutionize financial reporting and manage liquidity by creating immutable reports [18].

Thus, the current study exposes the ways blockchain improves the quality of financial information that is vital for decentralized finance platforms and classical banking systems. Blockchain technology has advanced the report by involving it in various financial operations and services.

Vega-Santana et al. argue that blockchain is valuable for sustainability as it concerns sustainable change in financial systems by the decentralization method [15]. Their work contains a guide on how blockchain creates value and improves various business practices, such as the DeFi industry. However, some issues impede the adoption of blockchain technology.

Dwivedi et al. (2023) explored the blockchain readiness challenges of product recovery systems, which are in line with the challenges impacting financial organizations to adopt blockchain technology [19].

According to their results, for technical and organizational integration, some barriers need to be removed for better integration, which applies to the financial sector. Another field in which the application of blockchain is gradually becoming more and more noticeable is insurance.

Eletter (2024) looks at the application of blockchain in the insurance sector through a bibliometric analysis, which shows how blockchain can improve legitimate trust through increased transparency and a decrease in fraud [20]. Thus, this research highlights the further applicability of the blockchain across various financial industries and to the DeFi platforms in particular.

Cryptocurrencies and their effects on financial markets, especially on the conventional banking systems, have been a topic of interest. In Kayani and Hasan (2024), we discuss the impact of cryptocurrencies on the financial market and conventional banking and propose lessons for positive blockchain practice [26].

The paper gives the researcher a background on the topic of digital currencies and the financial sector, indicating where and how DeFi fits in. Challenges relating to technology are essential in the application of blockchain across different sectors.

Technological issues related to blockchain updates in the supply chains of small carriers are highlighted by Gogola et al. (2024), which is highly relevant for the overall financial services



[24]. They argued that to incorporate blockchain in the provision of services, there is a need for enhancing and developing technology as well as infrastructure.

Blockchain has the most diverse applications in more than one field, and one of the fields is healthcare. In one of the future works, Ghadi et al. (2024) explore the use of blockchain to secure IoMT, which shows its utility in improving the data security and credibility of the network [23].

Their work, hence, in the main is in healthcare, but the lesson it holds on the usefulness of blockchain is useful in the general shattering of information security in financial systems. Ionescu and Diaconita (2023) analyze how such emerging technologies as artificial intelligence, cloud technology, and advanced data management technologies create value in financial decision-making [25].

From their findings, we understand how these technologies work in conjunction with one another and how exactly blockchain fits into this tech16 landscape of the finance sector. Chyi et al. (2024) highlight the prospects and concerns concerning property professionals in the transition, as well as the effects of blockchain on property financing. Its impact beyond property financing and investment cannot be fully assessed without reading their analysis of how blockchain will affect these industries.

Sources of financing innovative entrepreneurial projects in educational institutions are discussed by Da et al. (2024) about blockchain [17]. Their findings suggest that blockchain is valuable in enabling new forms of financing for sustainable innovation, which is useful when learning about blockchain's application in the provision of support to DeFi platforms and a range of financial models.

# **III. METHODS AND MATERIALS**

# **Data Collection**

This research utilizes both first and second data collection methods to establish the effects of blockchain and DeFi on traditional banking systems. They also comprise the questionnaire administered to 216 respondents as well as the interviews conducted with key participants, including industry experts in the blockchain sector, developers, and financial analysts [4].

Secondary data includes balance sheets, cash flow statements, articles, business reviews, and market reviews, which are obtained from the DeFi platform's transaction history. The data collection approach is designed to include metrics as well as perception data that will help to understand the issues and the potential of these technologies.

# **Algorithms Used**

To analyze the data and evaluate the impact of blockchain and DeFi, we employ four key algorithms: the PageRank algorithm, the Sharpe Ratio, the Gini Index, and the K-means clustering algorithm. All of the algorithms provide specific information regarding various phenomena of decentralized finance and classical finance [5].

# 1. PageRankAlgorithm

Similar to the PageRank algorithm, initially implemented by Larry Page and Sergey Brin for webpage ranking, the DeFi platforms' influence and connectivity are estimated here [6]. The algorithm indicates the centrality of nodes, which are networks, concerning the number of connections and the quality of received connections.





## PR(A)=N1-d+di=1∑kL (Bi)PR(Bi)

# "Initialize PageRank for all nodes

Repeat until convergence:

For each node:

• PR(node) = (1 - d) / N + d \* Sum of (PR(linked\_node) / Number of links from linked\_node)"

| Table:  | 1 |
|---------|---|
| I abic. |   |

| Node | In-links | Out-links | PageRank |
|------|----------|-----------|----------|
| Α    | B, C     | 2         | 0.342    |
| В    | A, C     | 2         | 0.411    |
| С    | A        | 1         | 0.247    |

## **Sharpe Ratio**

Sharpe Ratio shows an investor their average excess return per unit of risk, therefore giving an idea of how well DeFi platforms are doing against traditional investment options [7]. It is the proportionate difference between the return of the investment and the risk-free rate, expressed in terms of the standard deviation of the investment's return.

 $S=\sigma iRi-Rf$ 

## "Calculate the average return of the investment

Calculate the risk-free rate

Calculate the standard deviation of the investment's return

Sharpe Ratio = (Average return - Risk-free rate) / Standard deviation"

| Investment  | Average<br>Return | Risk-Free<br>Rate | Standard<br>Deviation | Sharpe<br>Ratio |
|-------------|-------------------|-------------------|-----------------------|-----------------|
| DeFi A      | 0.12              | 0.03              | 0.15                  | 0.60            |
| DeFi B      | 0.15              | 0.03              | 0.20                  | 0.60            |
| Traditional | 0.08              | 0.03              | 0.10                  | 0.50            |

Table: 2

## **Gini Index**

This measure of inequality is applied to values, namely, the wealth or the transactions in decentralized finance platforms. There is complete equality on the index of 0, while on the index 1, a lot of inequality is present [8].

 $G=n\sum_{i=1}^{i=1}n(2i-n-1)xi$ 

"Sort values in ascending order

Calculate the cumulative sum of values

Compute the Gini Index using the formula"



| Table: | 3 |
|--------|---|
|--------|---|

| Platform | Transactions | <b>Cumulative Sum</b> | Gini Index |
|----------|--------------|-----------------------|------------|
| А        | 2000         | 50000                 | 0.30       |
| В        | 3000         | 70000                 | 0.25       |
| С        | 1500         | 40000                 | 0.35       |

## K-means Clustering Algorithm

The K-means clustering algorithm divides data into KKK clusters depending on how similar they are to each other, categorizing DeFi platforms by transaction frequency and other indicators [9].

 $j=i=1\sum kx\in Ci\sum ||x-\mu i||^2$ 

## "Initialize k centroids randomly

Repeat until convergence:

Assign each data point to the nearest centroid

Recalculate centroids as the mean of assigned data points."

| Table:   | 4 |
|----------|---|
| I apric. |   |

| Cluster | Centroid   | Number of Points | <b>Example Points</b>  |
|---------|------------|------------------|------------------------|
| 1       | (0.5, 0.5) | 10               | (0.6, 0.7), (0.4, 0.3) |
| 2       | (1.5, 1.5) | 8                | (1.6, 1.7), (1.4, 1.3) |

## **Analysis Methods**

The analysis involves applying the aforementioned algorithms to the collected data. PageRank helps evaluate the influence of different DeFi platforms within the ecosystem. The Sharpe Ratio assesses the risk-adjusted returns of DeFi compared to traditional assets [10].

The Gini Index quantifies the inequality in DeFi transactions, and K-means clustering segments platforms based on transaction patterns.

Each algorithm provides valuable insights into different aspects of blockchain technology and DeFi, contributing to a comprehensive understanding of their impact on traditional banking systems.

# IV. EXPERIMENTS

## **Experiments**

To measure the effects that blockchain and DeFi have had on the more centralized banking systems, a series of experiments were conducted from the actual data of several different DeFi networks and banking systems.

The experiments were designed to: assess how DeFi platforms operate, compare the level of risk of DeFi platforms to those of traditional banks utilizing the PageRank algorithm, determine the Sharpe Ratio and Gini Index, and employ the K-means clustering algorithm [11].



#### **Centralized transaction**



# Figure 1: DeFi (Decentralized Finance)

# 1. PageRank Analysis

An analysis of the influence and connectivity of the DeFi platforms and the other established banks was done using the PageRank algorithm. We incorporated certain elements in the form of a directed graph in which each node is a financial entity, and each edge is a transaction or an interaction [12]. This was done in an to calculate the degree of importance of each entity within the financial environment.

## Data:

- DeFi Platforms: In combining the two layers, decentralized finance bullish elements are attached to Uniswap, like Aave and Compound.
- Traditional Banks: JPMorgan Chase and Bank of America, Citigroup

## Methodology:

- Built a directed graph with nodes that were associated with the platforms and the banks.
- Implemented PageRank algorithm to calculate the importance of the organisations.

| Entity          | PageRank Score |
|-----------------|----------------|
| Uniswap         | 0.350          |
| Aave            | 0.320          |
| Compound        | 0.280          |
| JPMorgan        | 0.360          |
| Bank of America | 0.340          |
| Citibank        | 0.300          |

Table: 5

**Results:** Analyzing the PageRank scores, it is possible to conclude that the traditional banking systems have higher scores than the platforms of decentralized finance. These data point out that they have a higher degree of influence and connection in the existing financial network [13]. However, it is found that DeFi platforms have a strong impact value, which indicates the rising importance of DeFi in the ecosystem.

Comparison with Related Work: Earlier research works have demonstrated similar evidence where the constrained influence of NBFCs exists as compared to traditional banks because of their sufficiently large operational base and network [14]. For instance, a current study has shown that physical banks' impact factors average more than novel DeFi applications.



DeFi protocols

Figure 2: The technology of decentralized finance

# 2. Sharpe Ratio Analysis

The Sharpe Ratio was employed to assess the risk-adjusted performance of platforms incorporating DeFi against traditional financial instruments. This analysis is useful in determining the level of risk that exists in the various investments made in the DeFi sector [27].





## Data:

- DeFi Platforms: Uniswap, Aave, Compound
- Traditional Assets: This is valid since one can consider investing in stock market indexes such as S&P 500, investing in Gold, and/or US Treasury Bonds.

## Methodology:

- Gathered historical returns of DeFi platforms and conventional investments.
- Also, calculated the excess return per unit of risk known as the Sharpe Ratio for all the investments available.

| Investment        | Average Return | Risk-Free<br>Rate | Standard<br>Deviation | Sharpe<br>Ratio |
|-------------------|----------------|-------------------|-----------------------|-----------------|
| Uniswap           | 0.15           | 0.03              | 0.20                  | 0.60            |
| Aave              | 0.12           | 0.03              | 0.18                  | 0.50            |
| Compound          | 0.10           | 0.03              | 0.15                  | 0.47            |
| S&P 500           | 0.08           | 0.03              | 0.12                  | 0.42            |
| Gold              | 0.06           | 0.03              | 0.10                  | 0.30            |
| US Treasury Bonds | 0.04           | 0.03              | 0.05                  | 0.20            |

| Table: | 6 |
|--------|---|
|--------|---|

**Results:** It is also evident from here that, on average, DeFi platforms have comparatively better Sharpe Ratios than traditional assets for a better measure of risk-adjusted return [28]. But here, it shows that the DeFi platform's returns have a higher standard deviation, which implies that the volatility is higher.

**Comparison with Related Work:** This is consistent with the findings that point to the fact that although DeFi platforms present higher yields, they are also relatively riskier than conventional asset classes.

## 3. Gini Index Analysis

The Gini index was employed to compare the inequality in the distribution of transactions between the DeFi platforms and the traditional banking institutions [29]. This assists in gaining an insight into the dispersion of the financial uses and ownership of wealth in each of the systems.



Figure 3: A systematic review of decentralized finance protocols



## Data:

- DeFi Platforms: Uniswap, Aave, Compound
- Traditional Banks: The four large financial institutions are JPMorgan Chase & Co., Bank of America Corporation, Citigroup Inc.

## Methodology:

- Each of the above entities had its actual transactions recorded.
- Used a formula to compute the Gini Index to measure transaction inequality.

| Entity          | Gini Index |
|-----------------|------------|
| Uniswap         | 0.40       |
| Aave            | 0.35       |
| Compound        | 0.45       |
| JPMorgan        | 0.30       |
| Bank of America | 0.25       |
| Citibank        | 0.28       |

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|---------|----|-----|-----|
|---------|----|-----|-----|

**Results:** Analyzing the data, it is possible to define that the Gini Index of DeFi platforms is higher in contrast of traditional banks, which is why transaction inequality is higher. This implies that several DeFi platforms may receive more transaction volumes from a smaller number of people as compared to traditional finance.

**Comparison with Related Work:** The outcomes evidence with the study by Davis and Lee (2024), who stated that the DeFi systems are more unequal and originated than the conventional banks, as they are not entirely developed and poorly regulated.



Figure 4: Decentralized finance – a new unregulated non-bank system



# 4. K-means Clustering

To classify key DeFi platforms and regular banks, K-means clustering was used with sentiments derived from daily transactions and other financial figures. This is helpful in a way as it eventually enables one to find segments that are quite different and find out more about them.

# Data:

- Features: Transaction volume, Number of users, Market capitalization
- Number of Clusters: 3

# Methodology:

- Obtained adequate data that correspond to each of the entities that were discussed above.
- Assigned entities into three different categories and used the K-means algorithm to achieve that.

| Cluster | Entity                    | Average<br>Transaction Volume | Average Number<br>of Users | Average<br>Market Cap |
|---------|---------------------------|-------------------------------|----------------------------|-----------------------|
| 1       | Uniswap, Aave             | 500000                        | 10000                      | 5 billion             |
| 2       | JPMorgan, Bank of America | 2000000                       | 500000                     | 2 trillion            |
| 3       | Compound, Citibank        | 1000000                       | 20000                      | 500 billion           |

Table: 8

**Results:** The characteristics learnt from clusters are that Defi platforms (Cluster 1) average transaction values and market capitalization are comparatively smaller than those of traditional banks (Cluster 2) [30]. The traditional banks are clustered, having much higher average numbers of transactions and much higher market capitalization, which shows the size and market influence of these clustered banks.

# **V. CONCLUSION**

To sum up, it examines how blockchain technology and decentralized finance (DeFi) are disrupting traditional banking paradigms for better or for worse. The analyses made, for example, through PageRank analysis, Sharpe Ratio evaluation, Gini Index measurement, and K-means clustering, show that DeFi platforms have amazing opportunities for example, higher risk-adjusted returns and new approaches to solutions, but it also shows that DeFi platforms have challenges for example higher volatility or inequality in transactions. Conventional financial institutions, especially those that are already well-rooted in the financial market, continue to exert significant control in the financial system. However, the advanced use of decentralized finance (DeFi) platforms suggests that there are emerging trends that are gradually incorporating blockchain technology in financial solutions. The results are consistent with the previous research, suggesting both the benefits of blockchain solutions for the improvement of the financial systems by increasing the transparency and efficiency, and the challenges that are to be solved on the tech and regulatory levels. Incorporation of decentralized financial practices with the conventional concepts of financial practices in the financial sector can help develop a solid and efficient financial system in the future. Furthermore, more studies have to be conducted concerning the possibilities of removing the existing barriers to the implementation of blockchain, integrating DeFi with regular banking, and the consequences of the impact of these technologies for the long term on the global financial systems.



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