ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 10, Issue 5,May 2024

Analyzation of the Bitcoin Blockchain: Financial Elements Behind The Adoption

T.Tejaswi[1], G.SriLakshmi[2],M.Peter[3], A.Vagesh[4], K.R.V.Siddhardha[5]
AssistantProfessor[2],Students[1],[3],[4],[5]
SRKInstituteofTechnology,DepartmentofInformation Technology[1],[2],[3],[4],[5]
Vijayawada, India.
Maill'd:tejaswi.talari@gmail.com[1], sree.gpk@gmail.com[2],makkinapeter777@gmail.com[3], vagesh.anagani@gmail.com[4],vishalsidddhardha03@gmail.com[5]

Abstract: ***In early 2009, alongside the emergence of blockchain technology, Bitcoin brought forth numerous benefits for both developed and developing nations. One notable advantage is its capacity to facilitate direct transactions without reliance on traditional banking systems, which is particularly beneficial for foreign currency exchanges like remittances due to lower transaction fees. Moreover, Bitcoin offers a degree of anonymity that enables frequent transactions. These benefits, combined with various other factors, led to Bitcoin's unprecedented popularity and a significant price surge in 2017. However, despite the widespread attention given to the Bitcoin blockchain, deciphering its source continues to pose difficulties because of the system's inherent anonymity. Consequently, understanding its social impact remains difficult. In this scenario, we make use of data such as the total count of Bitcoins in circulation and downloaded by clients, IP addresses associated with transactions, and W3c searches related to Bitcoin to gain insight into the evolution of the system in different parts of the world. By utilizing these indicators to represent user adoption, we've pinpointed various economic measures, including GDP per capita, trading freedom, and W3C penetration, as pivotal factors linked to the level of user engagement and profits.***

Keywords—- Bitcoin, Blockchain technology, Direct transactions, Traditional banking systems, Remittances, Transaction fees, Anonymity, Price surge, Social impact, Bitcoins in circulation, IP addresses, W3C searches, User adoption, Trading freedom, W3C penetration, Economic measures, User engagement, Profits.

I. INTRODUCTION

Bitcoin, introduced in 2009, emerged as a digital currency offering an alternative to traditional financial systems. It operates without centralized control by institutions, governments, or banks, and introduced the groundbreaking concept of blockchain technology. Bitcoin has seen significant growth in recent years, establishing itself as a robust entity and a subject of considerable interest for research. The potential future applications of blockchain and cryptocurrencies as a whole are highly promising, despite the technology being relatively new and still in its early stages of development.

Understanding the decentralized nature of Bitcoin as a leading example of blockchain-based digital currency poses a significant challenge. Ongoing research is thriving with various investigations into the Bitcoin blockchain. Much of this work focuses on analysing blockchain technology itself, particularly its development and application in diverse areas. Another important research area revolves around financial and economic aspects, with a key question being the evolution of transaction fees and issues related to regulatory frameworks and policies. From a sociological perspective, studying Bitcoin adoption presents difficulties due to the inherent opacity of the network.

Mechanized computerized types of cash, for instance, Bitcoin have the potential to create significant social impact by enabling fast and inexpensive transactions. It offers a method for handling tips, donations, and minor payments independently of conventional banking systems, paving the way for widespread adoption. In any case, as clients can create any numerous monikers they need, this impact is trying to gauge. Prior research exploring the social implications of Bitcoin has relied on external data sets, including the count of Bitcoin client software downloads by country and the amount of government-issued currency engaged in Bitcoin transactions on exchanges. Additionally, they have analysed Bitcoin exchange data. [10, 12]. One essential initial step in utilizing Bitcoin trading data, the deanonymization process involves clustering pseudonyms to uncover patterns among users. This approach serves two primary objectives: evaluating the security of the Bitcoin system [13] and understanding the characteristics of transactions [12, 14, 15]. [11] proposed a system which is an innovative congestion control algorithm named FAQ-MAST TCP (Fast Active Queue Management Stability Transmission Control Protocol) is aimed for high-speed long-latency networks. Four major difficulties in FAQ-MAST TCP are highlighted at both packet and flow levels.

Here, we suggest merging Bitcoin transaction data with external data sources to evaluate Bitcoin adoption on a country level. Examining the pivotal elements that may either boost motivation or impede advancement within the

Bitcoin community, we will delve into how these dynamics have changed over time using the information at hand. Likewise, with the introduction of express estimations, we collect and show an overall in the Bitcoin stream association, we exclude the role of monetary records in influencing transaction dynamics.

The structure of our paper is as follows: Segment 2 provides a diagram illustrating the datasets utilized and the preprocessing stage. We examine three distinct external data sources to assess their significance in evaluating Bitcoin user participation. In Segment 3, we detail Bitcoin user activity by country, highlighting the influence of various economic factors and analysing user behaviour patterns. In Segment 4, we apply methods to deanonymize Bitcoin transactions, creating a network of transactions among users and assigning countries based on their Internet Protocol (IP) addresses involved in these transactions. Afterward, we build a worldwide Bitcoin flow network using an expanded version of the gravity model of trade, examining the economic indicators related to these flows. Finally, Section 5 provides a summary and analysis of our findings.

II. LITERATURE SURVEY

Collection of data and pre-processing: In the process of gathering data and preparing it for analysis, we aimed to examine the Bitcoin adoption levels in different countries. In addition to gathering data directly from the Bitcoin blockchain using a block explorer service, we also sought supplementary information from three alternative sources. This included extracting the IP address of the main node associated with each transaction from the Bitcoin network (available through the API at blockchain.info [16]), as well as tracking the download count for Bitcoin Core, a prominent Bitcoin client. Additionally, we utilized data from Google Trends to gauge the overall interest in Bitcoin. Details regarding these datasets are presented in Table 2.

Blockchain with Bitcoin: All data contained within the Bitcoin blockchain is freely available online. We compiled a summary of Bitcoin transactions utilizing programming interfaces provided by blockchain.info. The data was collected over a period spanning from January 9, 2009, to February 25, 2016. To send and receive Bitcoin, users must generate Bitcoin addresses. For each transaction, we recorded the data, including the addresses of the sender and receiver's Bitcoin, the amount transferred, transaction fees, the height of the block along the position relative to the block. A few key points about the dataset we gathered from the Bitcoin blockchain are presented in Table 2. We utilized the Unix timestamp of the block's creation as the timestamp for each transaction. Although the blockchain does not provide the transaction's information, it includes the timestamp of block creation[18]. It is mined each to Contemplate that couple of blocks our, the block timestamp is a respectable middle person for our survey. As to trade totals, we changed them from BTC (Bitcoin cash) to USD, using an everyday transformation scale, as the Bitcoin cost has profoundly changed all through the long haul (see Informative supplement A.1).

IP Addresses: To gain an understanding of clients and their locations, we examine the IP addresses of the central points responsible for facilitating transactions within the Bitcoin network. Bitcoin for certain includes a snitch show where clients grant their new trades to all their related companions across the association and a couple of examinations have shown that communicating with a critical piece of the association the essential centre point/Intellectual property that grants a trade is probably owned by its creator. Therefore, we obtained the main hub's IP addresses which act as intermediaries in every trade from blockchain.info, with the aim of the block creation time being approximately 10 minutes[19,20,21]. We segregated the IPs based on their corresponding countries to conduct a financial evaluation at the national level, as outlined in A.3. Additionally, we are aware that some customers utilize Zenith to enhance their anonymity within the organization. Top is an online program that redirects connections through a virtual circuit to conceal the IP address from the rest of the organization. As part of the geo-restriction procedure, we automatically filtered out the transactions routed through Zenith exit centres (refer to Appendix A.2), which depicts less than 0.001% of the sum of total number of transactions.

A metric of pursuit in examining Bitcoin gathering involves tracking the number of IP addresses associated with exchange hubs that have been detected at least once within the Bitcoin network. Certainly, this provides insight into Bitcoin's reputation across various countries, as represented in Figure 1. We present the number of unique IPs (each counted only once) by country during our study period for a subset of countries with significant activity in the Bitcoin network. In below Section 3, we detail our methodology for selecting these countries.
Observing the increase in IP addresses that appeared in the system (as IP addresses of exit centres) over time in Figure 4, we observe a decline in the documented growth of IP addresses. Therefore, we focus our analysis on the period from March 2012 to May 2014.

Data	Coverage period	Characteristic	Source
Blockchain	2009/01/09 - 2016/02/25	For each transaction: input addresses, output addresses, amounts, fee, timestamp*	`blockchain.info`
IP	2009/01/09 - 2016/02/25**	For each transaction: IP address of the first node that relays the transaction. Time resolution of the block creation (≈ 10 minutes)	`blockchain.info`
Bitcoin client (Bitcoin Core [17])	2009/01/09 - 2015/06/05**	Number of Bitcoin Core downloads per country, daily aggregated	`sourceforge.net`
Google Trends time series	2009/01/09 - 2017/02/01	Evolution of the number of queries, per country with a week resolution. The data are normalized for each country between 0 and 100.	Google
Google Trends country interest	2009/01/09 - 2017/02/01	Assigns a score to countries based on relative in-country queries. The data are normalized between 0 and 100.	Google

Table 1: Summary of datasets gathered from different sources

Number of blocks	400 000
Number of transactions	111 793 127
Number of unique Bitcoin addresses	128 894 781

Table 2: Basic statistics regarding the dataset gathered from the blockchain.

Bitcoin client in General: In order to gain a deeper understanding of Bitcoin adoption, we also analyze the frequency of downloads for the Bitcoin Client. In light of everything, A Bitcoin client refers to software used to

handle and store Bitcoin addresses, enabling transactions on the Bitcoin network. Bitcoin Center which is known as Bitcoin client, can be found on sourceforge.net [22]. It provides several metrics regarding the number of downloads along with the downloaded information and the average per country, as illustrated in Figure 2. As various clients are in the existing and a couple of clients perform trades through electronic organizations, the data from Figure 1: Guide tending to the data pertains to the count of IP addresses emerging within the Bitcoin network categorized by country. It represents the overall number of unique IP addresses that are present in the Bitcoin network between September 2012 and May 2014, focusing on the countries selected for our study based on their activity (IP and users) in Segment 3.

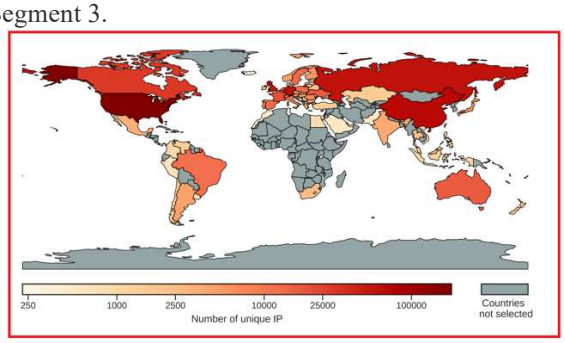

Figure 1: A diagram depicting a simplified flow of transactions in a blockchain.

The Bitcoin Center does not encompass every Bitcoin user. However, as outlined in Segment 3, we anticipate that it provides a comprehensive understanding of the overall activity and behaviours of users. As depicted in Figure 4, the duration for which client data is retained has been reduced over time. Consequently, we restrict the timeframe for downloads of the client to cover the period from 2011 through May 2014.

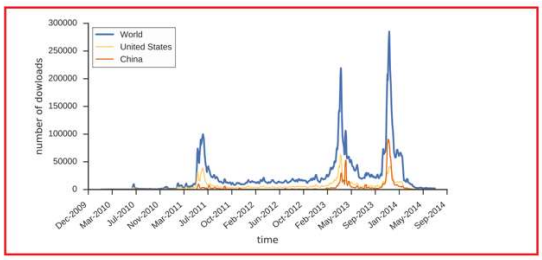

Figure 2:The growth in the Bitcoin client downloads, examining global trends as well as country-level trends for two of the leading countries in terms of download numbers.

Here we utilize Google Examples as an intermediary to encapsulate the entire idea discussed in [23]. Figure 3 illustrates the progress of each country in increasing the volume of searches corresponding to the sum of the total number of searches conducted, with a weekly target, for a specific keyword that we have designated as "Bitcoin". Furthermore, we eliminated the advantage provided by Google's regional search data by comparing the overall number of searches per country on a scale of 0 to 100. A score of 100 is elected to the country with the searches of Bitcoin as the highest number.

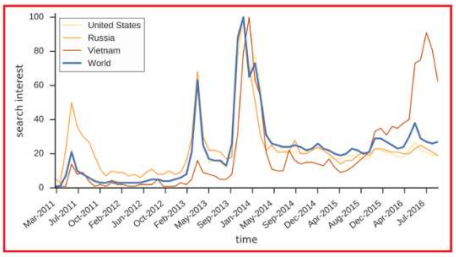

Figure 3: Google Trends data shows the time series of Bitcoin interest across specific countries.

Social-economic indexes by country: By illustrating, individuals who have embraced Bitcoin, we gathered datasets on financial records that are currently under examination to study the correlation between the obtained records and the Bitcoin community. Where we primarily concentrated on datasets that differ in the most advanced, affluent, and prosperous countries from those that are less developed. Table 2 provides a summary of the lists we utilized.Because there are multiple clients and some conduct transactions through electronic platforms, the data from the Bitcoin Center doesn't encompass every Bitcoin user. Yet, for Fragment 3, we anticipate that it provides a comprehensive understanding of overall user behaviour and trends. Since user data diminishes over time, as illustrated in Figure 4, we restrict the timeframe for client downloads from the beginning of 2011 to May 2014.

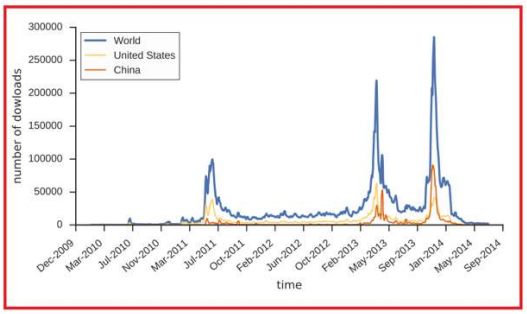

Figure 4: Trends in the growth of downloaded Bitcoin clients, both globally and at the country level for two of the largest countries based on download numbers.

Google Trends: In this context, we employ Google Examples as a representative of the entire concept discussed in [23]. Figure 5 illustrates the correlation between each country's increase in the volume of requests alongside the total number of inquiries made within a seven-day timeframe for a specific keyword, which we have defined as "Bitcoin" here. Additionally, we standardized the data of Google by region, utilizing the overall inquiries of each country. The measure ranges from 0 to 100, with 100 elected to the country with the highest number of searches on Bitcoin. [9] discussed that K-means transformation, histogram equalization, linear contrast stretching, and share-based features are all used to detect leukemia. A method for automatically classifying leukocytes using microscopic images is proposed. This proposed model used MATLAB to find leukemia cells in healthy blood cells, and it requires no medical equipment or expert and heavily relies on automation.

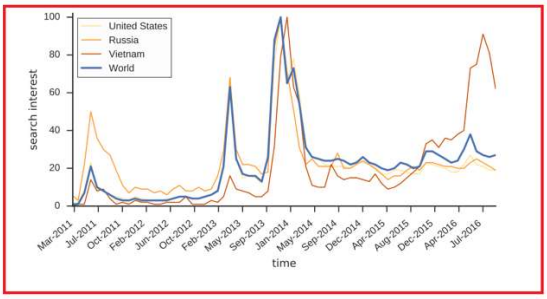

Figure 5: Time series data from Google trends depicting bitcoin interest across chosen countries.

III. METHODOLOGY

Country Financial records: To illustrate the users of Bitcoin, we collected datasets on financial records at the national level, solely focused on analyzing the relationship between these records and Bitcoin adoption. Our attention primarily centred on records distinguishing the mostdeveloped, affluent countries from the less developed ones. Table 2 provides a summary of the records utilized.

Bitcoin adoption at the national level: Exclusively concentrating on assessing the community on a national scale, we have pinpointed Bitcoin user downloads, IP hand-off centres, and Trends of Google as relevant data sources**.** Here, we demonstrate that these totals provide a comparable and reliable representation of the customer, thus, we opt to incorporate them as intermediaries to concentrate on group interaction. This critical step lays the foundation for two types of analysis. In either case, we show that countries with different manufacturing records display unique assembly patterns. Ultimately, we analyze the correlation between national economic records and Bitcoin assembly.

Network Flow: Following the allocation of a country to each client, we formed the Bitcoin trade alliance. Within this alliance, the centres represent countries, and the weighted connections indicate the volume of Bitcoins traded, converted into dollars. Coming out of this point forward, our focus will be on transactions conducted in 2013 and will involve the limited set of countries examined in the preceding section of the study. Figure 7 illustrates the global Bitcoin transaction network.

Flow Modelling: To understand which financial documents might represent the flow of Bitcoin, we construct a model based on the model of gravity, initially introduced by Jan Tinbergen in 1962 [32]. This is utilized to depict the bilateral flow of trade of various goods and services between countries. The fundamental structure of the model resembles Newton's law of gravity: it employs financial data representing the monetary size of nation A, denoted as Mama, to strengthen interactions, along with a variable representing the distance between nations, denoted as Dab, which weakens the intensity of interactions. With the addition of a constant G, this model is expressed as:

$$F_{ab} = G\frac{M_a^{\beta_1} M_b^{\beta_2}}{D_{ab}^{\beta_3}}$$

When considering Fab as the flow between nations a and b, and β1, β2, and β3 as coefficients with real values, the standard method for model fitting entails applying logarithms to both sides. This results in a logarithmic model, facilitating the execution of a linear regression [33], where the constant G transforms into β0.

$$\ln(F_{ab}) = \beta_1 \ln(M_a) + \beta_2 \ln(M_b) - \beta_3 \ln(D_{ab}) + \beta_0 \quad (2)$$

Here we utilize an expanded gravity model [34, 35, 36], and that implies we are thinking about extra factors. Calling ***{XabI}i∈J1,nK***, the n factors which may be either single nation amounts (for example the majority of Masses ***ma*** and **Mb**) or amounts connected with the several nations (a, b) (for example the distance Touch), the model can now be composed as:

$$\ln(F_{ab}) = \sum_{i=1}^{n} \beta_i \ln X_i^{ab} + \beta_0 \quad (3)$$

Positive values of βi are associated with factors Xab I which contributes to the magnitude of nations, at the same time negative values, all else being equal, represent factors that act like distances. However, this method fails to account for zero observations and uses ordinary least squares (OLS) to estimate the log-linearized equation which leads to critical biases under heteroskedasticity [37]. Alternatively, one can utilize its multiplicative form, as shown in equation 4, replacing linear regression with a Poisson regression.
The vector ***β = [β0 . . . βn]*** is estimated maximizing the likelihood

$$F_{ab} = \exp\left\{\sum_{i=1}^{n} \beta_i \ln X_i^{ab} + \beta_0\right\}$$

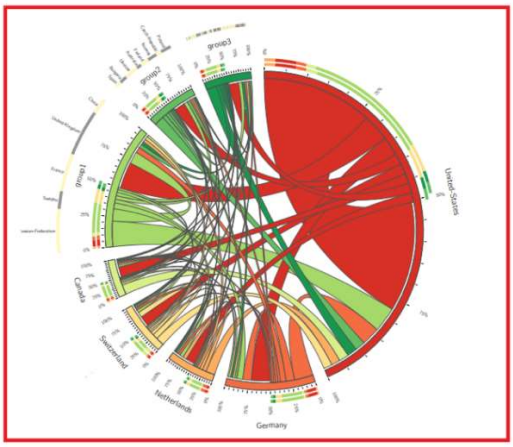

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Figure 6: Displaying the global movement of Bitcoin in 2013.

$$l(\boldsymbol{\beta}|\, X, F) = \sum_{\forall(a,b)} \left(F^{ab} \cdot (\boldsymbol{\beta} \cdot \mathbf{x^{ab}}) - e^{\boldsymbol{\beta}\cdot\mathbf{x^{ab}}}\right)$$

Here, F denotes a vector containing the Bitcoin transactions among different groups of countries, and X is an m × (n + 1) matrix. Each element of X, denoted by x subscript a, represents a vector Xab, where the values correspond to the factors when i belongs to the set J1,n, with a 1 appended to include the constant term β0.

This context contains the utilization of the following set of variables commonly appearing in trade literature: population, geographical distance, GDP per capita, and collaboration factors that identify countries sharing a

common language or geographic proximity. Additionally, we perceive a significant opportunity for trade, particularly through online platforms, as we observed (refer to Table 6) its correlation with Bitcoin adoption. Furthermore, in addition to the datasets mentioned earlier, we obtained datasets that include data on countries sharing either a geographic border or a common language [38]. Lastly, we employed a database that provides information on the distance between every pair of countries, calculated using city-level data, to analyze the geographical distribution of populations within each country [38].

Group 1	Group 2	Group 3
Czech	United Kingdom	Ukraine
Lithuania	Poland	Russia
Romania	Austria	France
Norway	Spain	Sweden
Finland	Slovenia	China
Bulgaria		Hungary
Japan		Austria
Belgium		Denmark

Table 3: correlated with the adoption of Bitcoin.

To identify the primary factors influencing the flow of Bitcoin among these financial records, we conduct a variable selection process. Introducing L1 regularization to the model. Subsequently, the variables are examined according to the constrain.

$$-l(\beta|X,Y)+\lambda\sum_{i=1}^{n}|\beta_i|$$

Next, the calculation of the average of CVk(λ), along with the standard deviation (SD) and the standard error (SE), is as follows:

$$SD(\lambda)=\sqrt{\text{var}\,(CV_1(\lambda)...CV_k(\lambda))}SE(\lambda)=\frac{SD(\lambda)}{\sqrt{k}}$$

IV. CONCLUSION

The examination of the Bitcoin blockchain, detailed in the provided report, offers valuable insights into the economic dynamics shaping its widespread acceptance. Notably, the research underscores Bitcoin's decentralized architecture, which enables direct transactions sans reliance on conventional banking systems. This attribute proves particularly advantageous for remittance purposes in developing nations, given the lower transaction costs involved.

Furthermore, the study elucidates the challenges inherent in gauging Bitcoin's social impact, owing to its intrinsic anonymity and the complexities associated with accurately tracking user adoption. Leveraging diverse datasets, including the total Bitcoin supply, transaction-associated IP addresses, and Google Trends metrics, has facilitated a comprehensive understanding of the economic drivers influencing Bitcoin adoption.

These analyses highlight several key factors, such as GDP per capita, trading freedom, and internet penetration, which exhibit correlations with the varying levels of Bitcoin engagement across different geographical regions. Such nuanced insights underscore the multifaceted nature of Bitcoin's integration into global financial landscapes.

V. FUTURE SCOPE

Exploring the trajectory of institutional adoption in the realm of Bitcoin and other cryptocurrencies presents a promising avenue for future research. With financial institutions and major corporations increasingly integrating cryptocurrencies into their portfolios, this trend holds the potential to foster greater market stability and shape regulatory strategies.

Additionally, investigating the ongoing advancements in blockchain technology, particularly the emergence of more energy-efficient consensus mechanisms such as Proof of Stake (PoS), could yield valuable insights into Bitcoin's future adoption and usability. Understanding the impact of these technological innovations on user behavior and market dynamics remains a crucial area for exploration.

Moreover, as regulatory landscapes continue to evolve, there arises a need for comprehensive studies on how regulatory changes influence the global distribution of Bitcoin users and overall market stability. Analyzing the effects of governmental and international regulatory frameworks on cryptocurrency adoption and market dynamics is imperative for grasping the future trajectory of Bitcoin and its counterparts in the financial ecosystem.

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