

Cryptocurrency: Potential, Prospects, Market, Challenges, Future and Way Forwards

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Abstract: Cryptocurrency represents a digital or virtual currency that relies on cryptographic security and operates through a distributed network encompassing numerous computers. The concept of the blockchain, which forms the basis of cryptocurrencies like Bitcoin and various other applications, was introduced by Satoshi Nakamoto in 2008 as a response to Europe's economic crisis. Satoshi's vision for Bitcoin was as an innovative payment method that circumvented central authorities, such as central banks. Instead, it relied on a chain of data blocks protected by cryptography, a concept later referred to as the blockchain. Initially, this technology gained prominence through its application in cryptocurrencies, with Bitcoin being the pioneering success story. In the present day, cryptocurrency, particularly Bitcoin, has witnessed a remarkable revolution, with the total cryptocurrency market capitalization now standing at \$2.79 trillion, equivalent to the world's eighth-largest economy. Globally, there are 730 cryptocurrency spot exchanges. However, despite its potential, promise, robustness, and numerous achievements, cryptocurrency grapples with various challenges and regulatory complexities that impede its widespread adoption in certain regions, as discussed in this research. This study serves as an exploratory examination of cryptocurrency's potentials, prospects, market dynamics, challenges, and its future, with a particular focus on Bitcoin.

Key words: Cryptocurrency, Bitcoin, Ethereum, blockchain, AI, wallet, NFTs, DeFi

Introduction

Blockchain is the underlying technology that enables the existence of cryptocurrencies, among other applications. Bitcoin is perhaps the most widely recognized cryptocurrency, and blockchain technology, as we know it today, was specifically designed to support Bitcoin. A cryptocurrency functions as a digital medium of exchange, similar to the US dollar, but it operates in the digital realm, utilizing cryptographic techniques and a specific protocol to validate fund transfers and oversee the creation of new monetary units. A blockchain serves as a decentralized ledger, recording all transactions across a peer-to-peer network. Utilizing this technology, participants can verify transactions without relying on a central clearing authority. The potential applications for blockchain extend to various areas, including fund transfers, trade settlements, voting systems, and many other domains.¹ Conversely, a cryptocurrency is a type of digital currency that is generated using cryptographic methods and binary data. Cryptocurrencies enable individuals to securely purchase, sell, or trade them, all without the involvement of a central monetary authority, such as a government or financial institution. Although cryptocurrencies can be used to exchange goods and services, they are predominantly utilized as a long or short-term investment strategy in the modern financial market. There exists a multitude of different cryptocurrencies, with Bitcoin being the most dominant and currently valued at over \$19,000.² It's crucial to emphasize that blockchain and cryptocurrency are distinct entities. Blockchain is the technology that underpins the cryptocurrency market and was originally developed to support the functionality of the world's largest cryptocurrency, Bitcoin. The fundamental aim of cryptocurrency is to address the prevalent issues associated with conventional currencies by returning control over currency to its holders, rather than a central monetary authority. Cryptocurrency achieves this by decentralizing money, removing the need for centralized intermediaries like banks to oversee transactions. Such a system theoretically eliminates the potential for financial crises, such as recessions, arising from a single point of failure. Furthermore, cryptocurrency has emerged as one of the most lucrative, albeit volatile, investments in recent years, offering ordinary individuals the potential to generate substantial wealth with well-timed investments.³

A cryptocurrency wallet stores the private keys that grant access to your cryptocurrencies, providing a secure and convenient location for sending and receiving your digital assets. These wallets can take the form of physical devices resembling USB drives or mobile applications. It's important to understand that these wallets do not store the cryptocurrencies themselves; instead, they safeguard the keys needed to access and transfer the cryptocurrencies.⁴ If the private key is lost, the associated funds become inaccessible, underscoring the critical importance of having a reliable cryptocurrency wallet.⁵ The world of cryptocurrency has experienced remarkable growth over the past decade, attracting significant attention as one of the most popular, profitable, and volatile investment opportunities of the 21st century. The first cryptocurrency, Bitcoin, was introduced in 2009 by an anonymous developer known as

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Satoshi Nakamoto. Initially conceived as a means for people to exchange digital currency for goods over the internet without the constraints of traditional financial systems, Bitcoin set the stage for the emergence of digital cash. However, the full extent of its potential as a profitable investment was largely unforeseen at the time, making it one of the most fruitful investments of the last decade.⁶

Blockchain can be defined as a sequence of blocks that store specific information in a secure,⁷ chronological, and immutable manner. When a block is filled with data, a new block⁸ is generated to continue the process. The origins of blockchain technology can be traced back to 1991 when researchers Stuart Haber and W. Scott Stornetta introduced it as a computational solution for time-stamping digital documents, making them tamper-proof and ensuring accurate dating. They accomplished this by creating a system based on cryptography where time-stamped documents were stored in a chain of blocks. In 2000, Stefan Konst expanded on this theory, proposing ideas for cryptographic secured chains and their implementation. It was in 2008 that Satoshi Nakamoto introduced the concept of "Distributed Blockchain" in his white paper titled "A Peer-to-Peer Electronic Cash System." He further improved upon the Merkle Tree model and developed a system that provided enhanced security and maintained a secure history of data transactions.⁹ The turning point for blockchain technology occurred in 2014 when it separated from digital currency, giving birth to Blockchain 2.0. Industries, including financial institutions, began shifting their focus from digital currency to blockchain technology development. In 2017, Japan recognized Bitcoin as a legal currency, and Bitcoin celebrated its 10th anniversary in 2018, although its value experienced a decline, dropping to \$3,800 by year-end. Major online platforms such as Google, Twitter, and Facebook also imposed bans on cryptocurrency advertising. In 2019, the Ethereum network witnessed over 1 million transactions per day. Amazon announced the general availability of the Amazon Managed Blockchain service on AWS.¹⁰ Ethereum transitioned from the Proof of Work (PoW) to Proof of Stake (PoS) consensus mechanism, merging the original Ethereum mainnet with Beacon Chain, which operates with Proof-of-Stake, resulting in a single chain.¹¹ This change led to a remarkable 99.9 percent reduction in Ethereum's energy consumption.¹²

Bitcoin is the most prominent cryptocurrency in the USA, accounting for 72% of cryptocurrency transactions. The Middle East represents 15% of the global cryptocurrency market as of January 2022, with Turkey leading in transaction volume. Among the G20 countries in January 2022, the UK had the highest number of recorded cryptocurrency exchanges (70), followed by Singapore (47), the US (40), and Hong Kong (27). Global forecasts indicate that by 2027, the global digital currency market will reach approximately \$1,200 million, representing a compound annual growth rate of nearly 5% for Bitcoin, Ethereum, Litecoin, Dogecoin, Ripple, and others. Nevertheless, the cryptocurrency market faced a \$150 billion loss in 2021. In comparison to 2021, cryptocurrency growth is anticipated to reach 5000% by January 2030. Over the last few years, the cryptocurrency market has experienced significant growth, but it has also been accompanied by numerous security challenges, resulting in hundreds of daily cybercrimes related to cryptocurrencies.¹³ Looking ahead, criminal activities in the crypto sphere are predicted to rise by almost 600% by 2030. Cybercrime incidents could potentially cost nearly \$5 trillion in 2030, marking an 800% increase from the estimated \$600 billion in 2018.¹⁴ The top 10 cryptocurrencies with the highest market capitalization constitute approximately 88% of the total cryptocurrency market value. These leading cryptocurrencies include Bitcoin, Ethereum, Ripple, Tether, Bitcoin Cash, Bitcoin SV, Litecoin, Binance Coin, EOS, and Tezos. As of 2021, around 1,000 new coins are introduced into the market each day. It's important to note that this analysis is based on a combination of primary and secondary information, aimed at evaluating the potential, prospects, market conditions, challenges, and the future of cryptocurrencies, with a particular focus on Bitcoin.

History of Cryptocurrency

David Chaum¹⁵ introduced a protocol resembling blockchain in his 1982 dissertation titled 'Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups.'¹⁶ The concept of a cryptographically secured chain of blocks was further outlined in 1991 by Stuart Haber¹⁷ and W. Scott Stornetta.¹⁸ Their primary objective was to create a system where document timestamps remained immune to tampering.¹⁹ In 1992, this initiative was expanded by Haber, Stornetta, and Dave Bayer²⁰ by incorporating Merkle trees into the design. This enhancement significantly improved efficiency by enabling multiple document certificates to be consolidated into a single block.²¹ Under the banner of their company, Surety, the hashes of document certificates have been published in The New York Times every week since 1995.²² The first decentralized blockchain concept was conceived by an individual or group using the pseudonym Satoshi Nakamoto in 2008.²³ Nakamoto introduced an innovative approach by utilizing a Hashcash²⁴-like method for timestamping blocks, eliminating the need for them to be signed by a trusted authority. Additionally, a difficulty parameter was introduced to maintain a stable rate of block additions to the chain.²⁵ The practical implementation of this design was carried out the

following year by Nakamoto as a central element of the cryptocurrency Bitcoin. In this role, it functions as the public ledger for recording all transactions on the network.²⁶

In August 2014, the Bitcoin blockchain file size, which contains records of all network transactions, had grown to 20 GB.²⁷ By January 2015, it had expanded to nearly 30 GB, and from January 2016 to January 2017, the Bitcoin blockchain swelled from 50 GB to 100 GB in size. By early 2020,²⁸ the ledger size had surpassed 200 GB. The terms "block" and "chain" were initially used separately in Satoshi Nakamoto's original paper but eventually merged into a single word, "blockchain," by 2016.²⁹ According to Accenture, the adoption rate of blockchains within the financial services sector reached 13.5% in 2016,³⁰ signifying entry into the early adopters' phase.³¹ In 2016, industry trade groups collaborated to form the Global Blockchain Forum under the Chamber of Digital Commerce's initiative.³² In May 2018, Gartner's³³ research revealed that merely 1% of CIOs had implemented any form of blockchain technology within their organizations, with only 8% of CIOs considering short-term planning or active experimentation with blockchain.³⁴ For 2019, Gartner reported that 5% of CIOs regarded blockchain technology as a 'game-changer' for their businesses.³⁵

Nakamoto initiated work on Bitcoin's code in 2007.³⁶ On August 18, 2008, either Nakamoto or an associate registered the domain name bitcoin.org and created a website at that address.³⁷ On October 31, Nakamoto published a white paper on the cryptography mailing list hosted at metzdowd.com, outlining a digital cryptocurrency³⁸ titled 'Bitcoin: A Peer-to-Peer Electronic Cash System.'³⁹ On January 9, 2009, Nakamoto released version 0.1 of the Bitcoin software on SourceForge and initiated the network by defining the genesis block of Bitcoin, labeled as block number 0⁴⁰, which came with a 50-bitcoin⁴¹ reward. Embedded within this block's coinbase transaction was the text: 'The Times 03/Jan/2009 Chancellor on brink of second bailout for banks,' citing a headline from the UK newspaper The Times published on that date.⁴² This text has been interpreted both as a timestamp and as a satirical comment regarding the perceived instability caused by fractional-reserve banking.⁴³ Nakamoto continued to collaborate with other developers on the Bitcoin software until mid-2010, personally making all changes to the source code. He later transferred control of the source code⁴⁴ repository and network alert key to Gavin Andresen,⁴⁵ assigned various related domains to prominent members of the Bitcoin community, and formally withdrew his recognized involvement in the project.⁴⁶ Nakamoto is believed to own between 750,000 and 1,100,000 bitcoins. During November 2021, when Bitcoin reached its highest value of over US\$68,000, this would have translated into a net worth of up to US\$73 billion, ranking him as the 15th wealthiest person globally at that time.⁴⁷

Background History of Cryptocurrency

A cryptocurrency, often referred to as crypto, is a digital currency⁴⁸ created to function as a medium of exchange over a computer network that operates independently of any central authority, such as a government or financial institution, for its regulation or maintenance.⁴⁹ It operates as a decentralized system, eliminating the need for traditional intermediaries, such as banks, when transferring funds between two parties.⁵⁰ Each individual's ownership of these digital coins is recorded in a digital ledger, a computerized database that employs robust cryptography to safeguard transaction records, oversee the generation of additional coins, and validate the transfer of coin ownership.^{51,52} Despite the term "cryptocurrency," these digital assets are not considered currencies in the traditional sense. While various classifications have been applied to them, including categorization as commodities, securities, or currencies, cryptocurrencies are generally regarded as a distinct asset class in practical terms.^{53,54} They do not exist in a physical form like paper money and are typically not issued by any central authority.⁵⁵ Cryptocurrencies commonly operate with decentralized control, in contrast to central bank digital currencies (CBDCs).⁵⁶ When employing decentralized control, each cryptocurrency operates using distributed ledger technology, often in the form of a blockchain, which functions as a publicly accessible database⁵⁷ for financial transactions.

A cryptocurrency exchange, alternatively known as a digital currency exchange (DCE), is a commercial enterprise that enables customers to engage in the trading of cryptocurrencies or digital currencies for other assets, which may include conventional fiat money or alternative digital currencies. Typically, a cryptocurrency exchange has the capability to transfer cryptocurrencies to an individual's private cryptocurrency wallet. Some exchanges can even convert digital currency balances into anonymous prepaid cards, facilitating cash withdrawals from ATMs worldwide.⁵⁸ Additionally, certain digital currencies are backed by tangible assets like gold.⁵⁹ It's worth noting that the creators of digital currencies are typically separate from the digital currency exchange responsible for facilitating currency trading.⁶⁰ Once again, a cryptocurrency wallet serves as a tool⁶¹, physical storage medium,⁶² software application, or service designed to store the public and/or private keys⁶³ required for conducting cryptocurrency transactions. Beyond the fundamental function of key storage, cryptocurrency wallets often include features for encrypting and/or digitally signing information.⁶⁴ In 2008, Bitcoin made its debut as the inaugural cryptocurrency, following the principles laid out by Satoshi Nakamoto in the paper titled 'Bitcoin: A Peer-to-Peer Electronic Cash System.'⁶⁵ This project was introduced as an electronic payment system that relied on cryptographic proof instead of

trust. It also introduced the concept of using cryptographic proof to validate and record transactions on a blockchain.⁶⁶ It's important to be aware that a cryptocurrency wallet can have known or unknown vulnerabilities, and potential attack vectors include supply chain attacks and side-channel attacks. In some extreme cases, even a standalone, offline computer can be vulnerable to hacking.⁶⁷ The first cryptocurrency, Bitcoin, was released as open-source software in 2009.⁶⁸ As of June 2023, the cryptocurrency market contained over 25,000 additional cryptocurrencies, with more than 40 of them having a market capitalization exceeding \$1 billion.⁶⁹ The table provided below showcases information on blockchain architecture and other key features of the top three cryptocurrencies.

Different layer	Bitcoin	Ethereum	Hyperledger
Application layer	Bitcoin trading	Ethereum trading	Enterpriseblockchain
Network layer	TCP-based P2P	TCP-based P2P	HTTP/2-based P2P
Contract layer	Script	Solidity/Script EVM	Go/Java Docker
Consensus layer	PoW	PoW/PoS	PBFT/SBFT
Data layer	Merkle tree	Merkle patricia tree	Merkle Bocket tree

Table 1: Blockchain architecture information⁷⁰

General Description and Chronological Development of Cryptocurrency

The symbol for Bitcoin is ₿, and it's recognized as a decentralized digital currency.⁷¹ Bitcoin can be denoted by currency codes BTC and XBT.⁷² Transactions involving Bitcoin are validated by network nodes using cryptographic methods and then recorded in a public distributed ledger known as a blockchain.⁷³ This cryptographic technology was introduced in 2008 by an anonymous entity operating under the pseudonym Satoshi Nakamoto.⁷⁴ Bitcoin came into active use in 2009⁷⁵ when it was made available as open-source software.⁷⁶ The term "bitcoin" was coined in a white paper published on October 31, 2008.⁷⁷ It combines "bit" and "coin"⁷⁸ to describe the digital currency. As of November 2021, the Library of Congress reported that nine countries have fully banned the use of Bitcoin,⁷⁹ and an additional forty-two countries have indirectly prohibited it. In contrast, some governments have embraced Bitcoin to varying degrees. For instance, El Salvador has officially recognized Bitcoin as legal tender, although its adoption among merchants remains limited.⁸⁰ Ukraine has welcomed cryptocurrency donations to support the resistance efforts against the 2022 Russian invasion, and Iran has employed Bitcoin to circumvent political sanctions. Bitcoin has faced scrutiny and has been labeled an economic bubble by at least eight laureates of the Nobel Memorial Prize in Economic Sciences.⁸¹ Moreover, the environmental impact of Bitcoin is significant.⁸² Its proof-of-work algorithm, used in the process of Bitcoin mining, is intentionally computationally demanding, resulting in escalating energy consumption. This heightened energy use has contributed to climate change.⁸³ According to the University of Cambridge, Bitcoin has generated an estimated 200 million tonnes of carbon dioxide emissions since its inception,⁸⁴ equivalent to approximately 0.04% of the total carbon dioxide released since 2009.⁸⁵



Figure 1: The cryptocurrency revolution⁸⁶ and world top cryptocurrencies⁸⁷

Bitcoin can be divided into eight decimal places,⁸⁸ allowing for precise amounts. Smaller units of Bitcoin include the millibitcoin (mBTC), equivalent to 1/1000 of a Bitcoin, and the satoshi (sat), which represents the smallest conceivable division of Bitcoin. The satoshi, named in honor of Bitcoin's creator, corresponds to 1/100,000,000 (one hundred millionth) of a Bitcoin.⁸⁹ One mBTC⁹⁰ consists of 100,000 satoshis. The Bitcoin blockchain functions as a public ledger that records all Bitcoin transactions.⁹¹ It's structured as a chain of blocks, with each block containing a cryptographic hash of the preceding block, all the way back to the initial or genesis block.⁹² A network of interconnected nodes running Bitcoin software is responsible for maintaining this blockchain.⁹³ Transactions, where payer X sends Y bitcoins to payee Z, are disseminated across this network through readily available software applications. Network nodes are capable of validating these transactions, appending them to their own copies of the ledger, and subsequently distributing these ledger updates to other nodes. To ensure the independent verification of ownership, each network node retains its own copy of the blockchain.⁹⁴ At intervals averaging about every 10 minutes, a new set of accepted transactions, known as a block, is created, included in the blockchain, and swiftly distributed to all nodes without the need for centralized control. This feature enables Bitcoin software to ascertain when a particular Bitcoin was expended, which is essential in preventing double-spending.⁹⁵ Unlike a traditional ledger that records transfers of tangible currency, Bitcoin only exists within the blockchain as the unspent outputs of transactions.⁹⁶ For a closer examination of individual blocks, public addresses, and transactions within blocks, a blockchain explorer⁹⁷ can be employed.

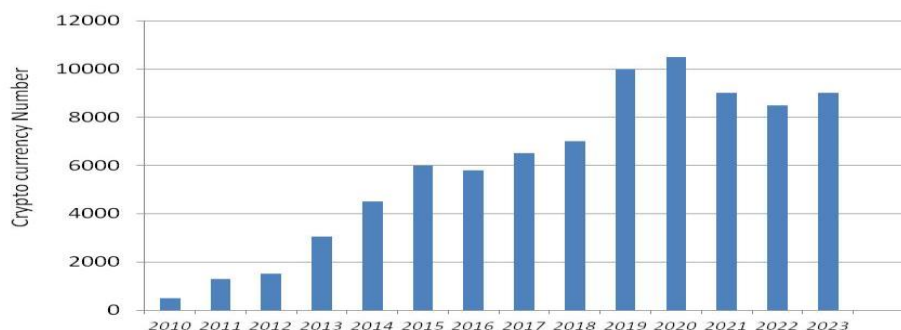


Figure 2: Number of different cryptocurrencies (2013-2023)⁹⁸

Transactions are established using a scripting language similar to Forth. Each transaction is made up of one or more inputs and one or more outputs. When a user initiates a Bitcoin transfer, they specify the destination address and the amount of Bitcoin they intend to send in an output. To ensure that the same Bitcoin isn't spent twice, each input must reference a prior unspent output in the blockchain.⁹⁹ The concept of using multiple inputs aligns with using multiple coins in a conventional cash transaction. Since transactions can have several outputs, users have the capability to send Bitcoin to multiple recipients in a single transaction. In situations where the total of inputs (the coins being used for payment) surpasses the intended sum of payments, an additional output is introduced to return the change back to the payer. Any satoshis in the input that aren't allocated to transaction outputs serve as the transaction fee.¹⁰⁰ While transaction fees are not mandatory, miners have the discretion to select which transactions to process and may prioritize those that offer higher fees. Miners base their selection on the fee paid in relation to the transaction's size in bytes, rather than the absolute fee amount. These fees are typically measured in satoshis per byte (sat/b). The transaction size depends on the number of inputs used to create the transaction and the number of outputs it contains. Initially, the blocks within the blockchain were confined to a size of 32 megabytes. The one-megabyte block size limit was introduced by Satoshi Nakamoto in 2010.¹⁰¹ However, this one-megabyte limit led to difficulties in transaction processing,¹⁰² including rising transaction fees and delayed transaction confirmation. Andreas Antonopoulos has suggested the Lightning Network as a potential solution for scaling and described it as a second-layer routing network.¹⁰³

Within the blockchain, bitcoins are assigned to bitcoin addresses. Generating a bitcoin address is a straightforward process involving the selection of a random valid private key and then deriving the corresponding bitcoin address.¹⁰⁴ This calculation occurs rapidly. However, the reverse operation, attempting to compute the private key¹⁰⁵ from a given bitcoin address, is practically infeasible. Users have the freedom to share a bitcoin address publicly without compromising the associated private key. The sheer volume of valid private

keys makes it exceedingly improbable that someone will generate a key pair that is already in use and contains funds. This vast number of valid private keys makes it practically impossible to crack a private key through brute force. To spend their bitcoins, the owner must possess knowledge of the matching private key and digitally sign the transaction.¹⁰⁶ The network validates the transaction using the public key, and the private key remains undisclosed.¹⁰⁷ If the private key is lost, the bitcoin network doesn't acknowledge any other proof of ownership, rendering the bitcoins inaccessible and effectively lost. For instance, in 2013, one user claimed to have lost ₺7,500, equivalent to US\$7.5 million at that time when he mistakenly disposed of a hard drive containing his private key.¹⁰⁸ Approximately 20% of all bitcoins are assumed to be lost, which would have had a market value of about US\$20 billion at July 2018 prices.¹⁰⁹ To uphold the security of bitcoins, the private key must be kept confidential. If the private key is exposed to a third party, such as through a data breach, that third party can use it to pilfer any associated bitcoins.¹¹⁰ However, up to December 2017, approximately ₺980,000 worth of bitcoins were stolen from cryptocurrency exchanges.¹¹¹ In terms of ownership distribution, as of December 28, 2022, 9.62% of bitcoin addresses possess 98.51% of all bitcoins ever mined.¹¹² The most substantial of these addresses are assumed to be owned by exchanges that are safeguarding their bitcoin holdings in cold storage.

Mining is a service for maintaining records that relies on the computational processing power of computers.¹¹³ Miners uphold the blockchain's consistency, integrity, and immutability by repetitively grouping newly broadcasted transactions into a block. This block is then disseminated across the network and validated by recipient nodes. Each block contains a SHA-256 cryptographic hash of the previous block, thereby connecting it to the preceding block and bestowing the blockchain with its name.¹¹⁴ For a new block to be accepted by the rest of the network, it must incorporate a proof-of-work (PoW).¹¹⁵ The PoW necessitates miners to identify a number known as a nonce, which is a number used only once. This nonce, when hashed together with the block's content, must yield a result that is numerically smaller than the network's difficulty target.¹¹⁶ While this PoW is easy for any network node to verify, it's extremely time-consuming to generate. Miners have to test numerous nonce values, typically in the sequence of ascending natural numbers, like 0, 1, 2, 3, 4, 5, before they chance upon a result that's smaller than the difficulty target. This is because the difficulty target is exceedingly small compared to a typical SHA-256 hash, and consequently, block hashes must have numerous leading zeros.¹¹⁷

The amount of work required to produce a block can be altered by adjusting the difficulty target. Approximately every 2,016 blocks, which translates to around 14 days with an average of roughly 10 minutes per block, nodes deterministically modify the difficulty target based on the recent rate of block creation. This adjustment aims to maintain the average time between new blocks at ten minutes.¹¹⁸ In this way the system automatically adapts to the total amount of mining power on the network.¹¹⁹ To generate a block hash smaller than the difficulty target,¹²⁰ it takes, on average, 122 sextillion (122 thousand billion billion) attempts, as of April 2022. Computations of this magnitude are prohibitively expensive and necessitate specialized hardware.¹²¹ The proof-of-work system, in conjunction with the linking of blocks, renders alterations to the blockchain incredibly challenging. This is because, for changes made to one block to be accepted,¹²² an attacker would have to modify all subsequent blocks in the chain. Since new blocks are continually being generated, the difficulty of changing an older block increases with time and the growing number of subsequent blocks, also referred to as confirmations of the given block.¹²³ The bulk of mining power is aggregated in mining pools, which serves to reduce income variability among miners.¹²⁴ Independent miners might have to work for several years to mine a single block of transactions and receive compensation. In a mining pool, each participating miner is remunerated whenever any participant generates a block. This payment is proportionate to the individual miner's contribution to the pool's collective work.¹²⁵

Every 10 minutes, the miner who successfully discovers the new block is granted permission by the rest of the network to claim all the transaction fees from the transactions included in the block.¹²⁶ Additionally, they receive a predetermined reward of newly created bitcoins,¹²⁷ which stood at ₺6.25 per block as of May 11, 2020. This reward is obtained by incorporating a special transaction called a coinbase into the block¹²⁸, with the miner designated as the payee. It's important to note that every bitcoin in existence has been generated through such transactions.¹²⁹

The Bitcoin protocol dictates that the block reward decreases by half every 210,000 blocks, or roughly every four years, until a total of ₺21 million bitcoins is generated.¹³⁰ The final new bitcoin is anticipated to be generated around the year 2140. Beyond this point, miners will be rewarded solely through transaction fees.¹³¹ Given that Bitcoin is decentralized, it operates without a central authority.¹³² The network is entirely peer-to-peer, devoid of central servers and centralized storage.¹³³ The bitcoin ledger is distributed,¹³⁴ public, and can be stored on any computer. The network lacks a single administrator, and the ledger's maintenance is carried out by a network of miners with equal privileges. Generally, anyone can become a miner, but not necessarily from every country.

Additions to the ledger are maintained through competition, and until a new block¹³⁵ is added, it remains uncertain which miner will create it. The issuance of bitcoins is decentralized, with rewards granted for generating new blocks. The process of creating a new bitcoin address, which is akin to a bank account for bitcoins, requires no approval, and sending a transaction to the network doesn't necessitate approval¹³⁶ either, as the network merely validates the transaction's legitimacy. However, this is subject to the authorization of certain countries.¹³⁷

On the contrary, some researchers have noted a "trend toward centralization." Although bitcoins can be sent directly from one user to another, intermediaries are commonly employed¹³⁸. Bitcoin miners frequently join large mining pools to mitigate income fluctuations.^{139,140} Because miners verify network transactions, network decentralization relies on the absence of a single miner or mining pool holding 51% of the hashing power. This prevents double-spending, assures transaction verification, and ensures miners earn income.¹⁴¹ In 2013, a mere six mining pools had control over 75% of the overall bitcoin hashing power.¹⁴² In 2014, Ghash.io, a mining pool, obtained 51% of hashing power, raising significant concerns about network security. To address this, the pool voluntarily capped its hashing power at 39.99% and urged other pools to act responsibly for the network's benefit.¹⁴³ By around 2017, over 70% of hashing power and 90% of transactions were originating from China.¹⁴⁴ Researchers have also noted a "small set of entities" controlling various parts of the ecosystem, including client software maintenance, online wallets, and simplified payment verification (SPV) clients.¹⁴⁵

Bitcoin is pseudonymous, meaning that funds are associated with bitcoin addresses¹⁴⁶ rather than real-world entities. While owners of bitcoin addresses aren't explicitly identified, all blockchain transactions are publicly recorded. Transactions can be connected to individuals by cross-referencing public transaction data with known information about the owners of specific addresses.¹⁴⁷ Additionally, bitcoin exchanges that trade bitcoins for traditional currencies may be legally required to collect personal information to enhance financial privacy.¹⁴⁸ To maximize privacy, a new bitcoin address can be generated for each transaction.¹⁴⁹ While the Bitcoin network treats each bitcoin equally, applications and individuals using the network can choose not to observe this principle. For instance, they can refuse bitcoins from transactions associated with questionable origins.¹⁵⁰ An example of this occurred in 2012 when Mt. Gox froze the accounts of users who had deposited bitcoins that were known to be stolen.¹⁵¹

A wallet contains the necessary information to carry out bitcoin transactions. While wallets are often described as a place to store bitcoins, they are, by nature of the system, inseparable from the blockchain transaction ledger.¹⁵² A wallet, more accurately defined, is a repository for the digital credentials required to access and spend one's bitcoin holdings. Bitcoin uses public-key cryptography, which generates two cryptographic keys: a public one and a private one.¹⁵³ At its core, a wallet is a collection of these keys. The first wallet program, initially named Bitcoin and sometimes referred to as the Satoshi client, was released in 2009 as open-source software¹⁵⁴ by Satoshi Nakamoto. After the release of version 0.9, the software bundle was renamed Bitcoin Core to distinguish it from the underlying network.¹⁵⁵ Bitcoin Core is arguably the most well-known implementation or client,¹⁵⁶ although variations like Bitcoin XT, Bitcoin Unlimited, and Parity Bitcoin exist.^{157,158}

Wallet software becomes a prime target for hackers due to the enticing potential for stealing bitcoins.¹⁵⁹ To mitigate these risks, a method called "cold storage" is employed, ensuring that private keys remain impervious to hackers.¹⁶⁰ Cold storage achieves this by maintaining private keys offline at all times, typically by generating them on a device that remains disconnected from the internet.¹⁶¹ The essential components required for spending bitcoins are securely stored offline using various methods, ranging from dedicated hardware wallets to basic paper records of the private key.¹⁶² A hardware wallet, regarded as a computer peripheral, authorizes transactions as directed by the user¹⁶³. These devices house private keys and perform the signing and encryption processes internally, without sharing sensitive information with the host computer, except for already signed transactions that are unchangeable. Since hardware wallets never expose their private keys, even in cases of compromised computers infected with malware, there is no vulnerability for accessing or pilfering these keys.¹⁶⁴ During the setup of a hardware wallet, a user establishes a passcode, ensuring that it's necessary to access funds from the wallet.¹⁶⁵ On the other hand, a paper wallet is created by generating a key pair on an internet-disconnected computer. The private key is then transcribed or printed onto paper before being wiped from the computer. This paper wallet can be stored in a secure physical location for later access¹⁶⁶. Physical wallets can also adopt the form of metal token coins with a private key concealed under a security hologram in a recessed area on the reverse side.¹⁶⁷ The security hologram self-destructs when detached from the token, indicating that the private key has been accessed. These tokens were initially produced in base metals like brass, but as the value and popularity¹⁶⁸ of bitcoin increased, precious metals were utilized. Gold¹⁶⁹ tokens with face values as high as \$1,000 have been minted. The British Museum's coin collection¹⁷⁰ features four specimens from the earliest series of funded bitcoin tokens, with one currently on display in the museum's money gallery.^{171,172}

The domain name bitcoin.org was officially registered on the 18th of August in 2008.¹⁷³ On the 31st of October in that same year, a link to a paper written by an individual or group operating under the pseudonym Satoshi Nakamoto, titled "Bitcoin as a Peer-to-Peer Electronic Cash System," was shared on a cryptography mailing list.¹⁷⁴ In January 2009,¹⁷⁵ Nakamoto released the open-source bitcoin software to the public. However, Nakamoto's true identity has remained shrouded in mystery.¹⁷⁶ Following initial proof-of-concept transactions, bitcoin found its first substantial user base in illicit markets, most notably on Silk Road.¹⁷⁷ This online marketplace, operational for approximately 30 months from February 2011, exclusively utilized bitcoins for transactions, amounting to \$9.9 million, equivalent to about US\$214 million.¹⁷⁸ Research conducted by the University of Cambridge in 2017 estimated that there were between 2.9 to 5.8 million unique users employing cryptocurrency wallets, with the majority utilizing bitcoin.¹⁷⁹ In December 2019, YouTube initially removed content related to bitcoin and other cryptocurrencies but later reversed this decision after acknowledging their error.¹⁸⁰ In February 2019, the Canadian cryptocurrency exchange Quadriga Fintech Solutions collapsed, resulting in the disappearance of around \$200 million¹⁸¹. By June 2019, bitcoin's price had rebounded to \$13,000.¹⁸² On the 19th of January 2021, entrepreneur Elon Musk added "Bitcoin" to his Twitter profile and posted a tweet stating, "in retrospect, it was inevitable," which led to a brief surge in the price of bitcoin, increasing by about \$5,000 in just an hour to reach US\$37,299.¹⁸³ On the 25th of January 2021, Microstrategy announced that it continued to accumulate bitcoin, amassing holdings of \$70,784 worth \$2.38 billion.¹⁸⁴ In September 2021, El Salvador officially recognized bitcoin as legal tender alongside the US dollar.¹⁸⁵ Later, on the 27th of April 2022, the Central African Republic also adopted bitcoin as legal tender, alongside the CFA franc.^{186,187} Investors have been drawn to the field of bitcoin mining.¹⁸⁸ According to a study conducted by Paolo Tasca in 2015, bitcoin startups raised nearly US\$1 billion in funding over a three-year period spanning from Q1 2012 to Q1 2015.¹⁸⁹ As of the 30th of September 2014, it was observed by Mark T. Williams that bitcoin exhibited volatility levels seven times greater than gold, eight times higher than the S&P 500, and 18 times greater than the US dollar.¹⁹⁰

Bitcoin is a digital asset tailored for use in peer-to-peer transactions, functioning as a form of currency.¹⁹¹ According to The Economist in January 2015, The cryptocurrency possesses three qualities that are valuable in a currency: it is challenging to acquire, has a limited supply, and is easily verifiable.¹⁹² However, some researchers argue that, as of 2015, bitcoin's primary role is as a payment system rather than a conventional currency.¹⁹³ Research from the University of Cambridge indicates that, in 2017, between 2.9 million and 5.8 million unique users utilized cryptocurrency wallets, with a majority of them focusing on bitcoin.¹⁹⁴ The user base has seen substantial growth since 2013, when the numbers ranged from 300,000 to 1.3 million users.¹⁹⁵ As of 2018, the majority of bitcoin transactions occurred on cryptocurrency exchanges rather than in merchant transactions.¹⁹⁶ Bitcoins can be acquired through digital currency exchanges.¹⁹⁷ François R. Velde, a Senior Economist at the Chicago Fed, has described bitcoin as an "elegant solution to the problem of creating a digital currency." In 2017, bitinfocharts.com reported 9,272 bitcoin wallets holding more than \$1 million worth of bitcoins.¹⁹⁸ The exact number of bitcoin millionaires remains uncertain since an individual may possess multiple bitcoin wallets. Some prominent companies, including SpaceX,¹⁹⁹ Tesla²⁰⁰, and MicroStrategy,²⁰¹ have invested in bitcoin as a means to preserve value. In the United States, cryptocurrency donations to federal political campaigns have been permitted since 2014. Several U.S. states have specific rules regarding such contributions for state-level elections.²⁰² The 2022 re-election campaign of Colorado Governor Jared Polis, a Democrat, officially accepted bitcoin and other cryptocurrencies.²⁰³ Bitcoin, as well as other cryptocurrencies, has been likened to an economic bubble by at least eight Nobel Memorial Prize in Economic Sciences laureates, including Robert Shiller,²⁰⁴ Joseph Stiglitz,²⁰⁵ and Richard Thaler.²⁰⁶ Economist and columnist Paul Krugman has characterized bitcoin as "a bubble wrapped in techno-mysticism inside a cocoon of libertarian ideology."²⁰⁷ Nouriel Roubini, an economist at New York University, has even gone so far as to call bitcoin the "mother of all bubbles,"²⁰⁸ while University of Chicago economist James Heckman has drawn parallels to the 17th-century tulip mania.²⁰⁹ In contrast, Robert Shiller contends that bitcoin is not a bubble and is experiencing a period of expansion, which he likens to an epidemic.²¹⁰

Category	Double-Entry	Bitcoin (POW Accounting)
Greed Effect	Fraud, other aggressive accounting practices	Under the correct conditions, deters motivation for fraudsters and encourages actors to play by the rules
Audit	Audited historically	Audited in real time
Audit Quality	Reasonable Assurance	Absolute Assurance
Accounting + Audit Dependence	Human professional judgment + software	Largely software driven
Unit of Account	Fiat / Crypto denomination of choice	bitcoin

Accuracy	Pre-audit, accuracy depends on quality of financial statement control design and execution	Accuracy depends on users running compatible client versions, non-buggy code, and a majority of hashrate being honest
Fraud Cost	Cheap	Expensive
Determining intent (Fraud or Honest Mistake)	Difficult	Easy, and obvious
Fraud Detection	After the fact	Immediate
Network Effect Upside	Average - can run double entry accounting with your own local currency (including Bitcoin)	Very Strong - need to use the network incentive token (i.e. bitcoin) to access available assurances
Accounting Dependence	Run independently – fraud in Company A largely does not affect Company B	Run independently – but fraud within the accounting system causes large disruption for all stakeholders
Ledger	Private	Public
Redundancy	Low- ledger stored by a few parties at most	High - ledger stored by a large amount of parties
Ledger Entry Rights	Closed - only company employees allowed to make entries	Open - anyone can create entries
Entries	Subject to change	Immutable
Entry Finality (Timing)	Delayed- post annual audit	After x amount of blocks that makes it infeasible to rewrite ledger history
Scalability	High	Low

Table 2: Bitcoin as an accounting revolution medium decentralized²¹¹

Statistics of Different Cryptocurrencies, Owner Countries and Market Forecast

As of August 2022, there are a total of 84.02 million cryptocurrency wallets worldwide. This represents a significant increase from 2015 when there were only 3.16 million crypto wallets globally. The top five cryptocurrency exchanges, determined by factors like traffic, liquidity, and trading volumes, are Binance, Coinbase Exchange, FTX, Kraken, and KuCoin. Due to the decentralized and largely unregulated nature of cryptocurrencies in most countries, these exchanges are not obligated to register with a centralized authority. This limited regulation makes it extremely challenging to ascertain the exact number of cryptocurrency exchanges. However, it is estimated that there are approximately 504 exchanges in operation today. About half of these are tracked and established, while the other half are still in the early stages of development. The very first decentralized cryptocurrency was Bitcoin, introduced in 2009 by an anonymous developer known as Satoshi Nakamoto. Bitcoin continues to be the leading cryptocurrency on the market, holding the #1 ranking.²¹² As of February 2023, Bitcoin boasts a market capitalization of over \$457 billion. In fact, Bitcoin's price has surged by a staggering 46,449,400% since 2010. To put this in perspective, in 2010, the peak price of Bitcoin was a mere \$0.09, while today, the value of a Bitcoin exceeds \$23,000. Many market analysts anticipate that Bitcoin's price could reach \$100,000. Notably, 65% of all cryptocurrency users hold Bitcoin. Apart from Bitcoin, the most prominent cryptocurrencies are Ethereum, Tether USD, Binance Coin (BNB), and USD Coin, as of February 2023. However, these cryptocurrencies have considerably smaller market capitalizations compared to Bitcoin. For example, Ethereum's market cap stands at \$202 billion, whereas Bitcoin's market cap is \$457.16 billion.

The popularity of a cryptocurrency can be gauged in various ways, including its trading frequency, the number of owners, or the volume of transactions it facilitates. Nevertheless, the most common metric used is market capitalization, which is calculated by multiplying a coin's price by the number of coins in circulation. Bitcoin is often regarded as the pioneer of cryptocurrencies, having been in existence the longest and enjoying widespread name recognition. It is the only cryptocurrency that the majority of people are familiar with. On the other hand, Ethereum is considered a second-generation cryptocurrency and has maintained its position as the second-largest cryptocurrency by market capitalization since early 2016. Technically, Ether is the currency, while Ethereum is the network. Its claim to fame lies in its utilization of smart contracts. Many other cryptocurrencies, along with over 3,000 decentralized applications (dApps),

run on its blockchain. Ethereum operates as a nonprofit enterprise and is not a deflationary currency like Bitcoin, although measures have been taken to prevent the possibility of an infinite supply of Ether. Ethereum has faced criticism regarding security and scalability issues, and recently, transaction costs on its network have risen significantly. Regarding its environmental impact, a single Ethereum transaction consumes more energy than the average U.S. household uses in a week, and one Ethereum transaction has a carbon footprint equivalent to 141,000 Visa transactions. In terms of transaction speed, Ethereum's blockchain can handle 13 transactions per second, and the confirmation time is around five minutes. The ranking and market capitalization of the top five cryptocurrencies as of February 2023 are detailed in the table below. Additionally, the top 15 cryptocurrencies by market capitalization as of January 2022 are displayed in Figure 3 for reference.

Cryptocurrency	2023 Market Cap
Bitcoin	\$457.16 billion
Ethereum	\$202.46 billion
Tether	\$70.97 billion
BNB	\$47.77 billion
USD Coin	\$42.46 billion

Table 3: Five largest cryptocurrencies by market capitalization²¹³



Figure 3: Top 15 largest cryptocurrencies by market capitalization²¹⁴

As of 2023, it is estimated that there are approximately 420 million cryptocurrency users worldwide. The adoption of cryptocurrencies has experienced remarkable growth over the past few years. Between 2018 and 2020, the global number of cryptocurrency users surged by 190%. The growth rate of the cryptocurrency industry has continued to accelerate in the past year.²¹⁵ When it comes to cryptocurrency ownership as a percentage of the population, the leading country is the United Arab Emirates, where 27.67% of the population owns cryptocurrencies as of 2023. In terms of population percentage, Vietnam ranks second, with 26% of its population using cryptocurrencies. Following closely is the United States, where 13.22% of the population possesses cryptocurrencies. The Philippines comes next, with 13% of its population engaged in cryptocurrency usage, and India follows with 11.5% of its population owning cryptocurrencies.²¹⁶ In terms of the total number of cryptocurrency owners, India takes the top spot with 157.6 million crypto owners as of 2023. The United States is the second-largest country in terms of cryptocurrency ownership, with 44.3 million crypto owners. Other prominent countries in cryptocurrency ownership include Vietnam with 25.9 million owners, China with 19.9 million owners, and Brazil with 17.8 million owners.²¹⁷ The United States leads the world in the number of cryptocurrency ATMs, with 17,436 operational crypto ATMs as of 2021.²¹⁸ The United States significantly surpasses all other countries in the sheer number of cryptocurrency ATMs. Additionally, other countries with notable numbers of crypto ATMs include Canada with 1,464 ATMs, the United Kingdom with 200 ATMs, Austria with 157 ATMs, and Spain with 138 ATMs. The growth rate of cryptocurrency ATMs in the United States continues to outpace the rest of the world.²¹⁹ The number of cryptocurrency owners in different countries worldwide is illustrated in Figure 4 below, while Figure 5 depicts the trend in cryptocurrency ownership as a comparative percentage of users in various countries.

NUMBER OF CRYPTO OWNERS BY COUNTRY 2023

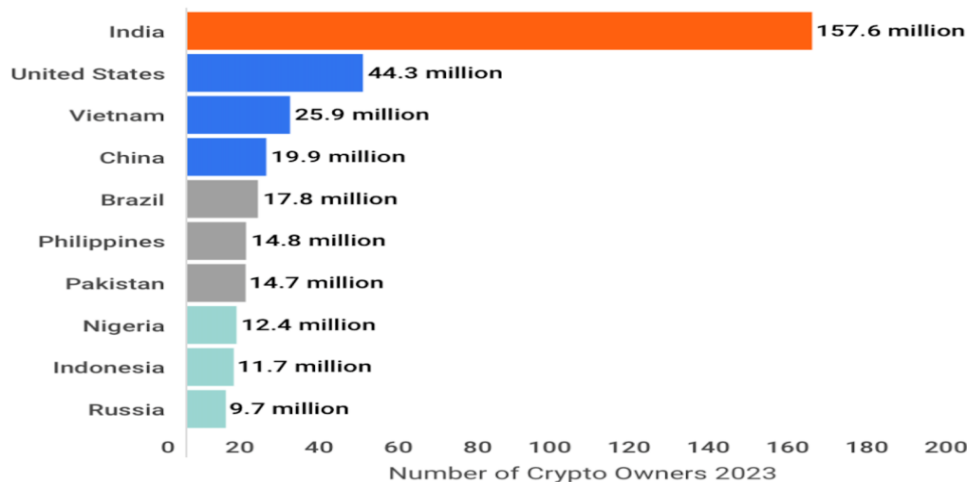


Figure 4: Number of crypto owner by different countries around globe²²⁰

The report anticipates that the global cryptocurrency market will experience a Compound Annual Growth Rate (CAGR) of 56.4% during the forecast period from 2019 to 2025. This cryptocurrency market analysis encompasses an examination of key regions, including North America, Europe, Asia-Pacific, and RoW, over the period from 2017 to 2025. The report offers a comprehensive exploration of factors such as drivers, constraints, opportunities, demand catalysts, market size, forecasts, and trends within the worldwide cryptocurrency market from 2017 to 2025. Furthermore, it amalgamates primary and secondary research findings.²²¹ Looking ahead, the global Blockchain technology market is projected to exhibit a CAGR of 68.4% by 2026. In contrast, the number of global crypto wallets has experienced exceptional growth, increasing by 1,271.97% since 2016. To provide some context, in January 2016, there were 5.78 million crypto wallets across the globe, and as of August 2022, this number has surged to 84.02 million crypto wallets. Nevertheless, cryptocurrency adoption rates are expected to continue rising,²²² accompanied by an anticipation of increased regulatory measures in the near future.²²³ The global crypto wallet market was valued at approximately USD 8.42 billion in 2022 and is estimated to observe a Compound Annual Growth Rate (CAGR) of 24.8% from 2023 to 2030. A primary growth driver for this market is the expanding acknowledgment of cryptocurrencies as a legitimate asset class.²²⁴ With recognition growing among both individual investors and institutional participants, there is an increasingly conspicuous demand for secure and user-friendly storage solutions. Additionally, heightened awareness of the pivotal role of cybersecurity in the cryptocurrency realm is another substantial factor.²²⁵ As the value of digital assets continues to rise, individuals are becoming more concerned about safeguarding their investments.²²⁶

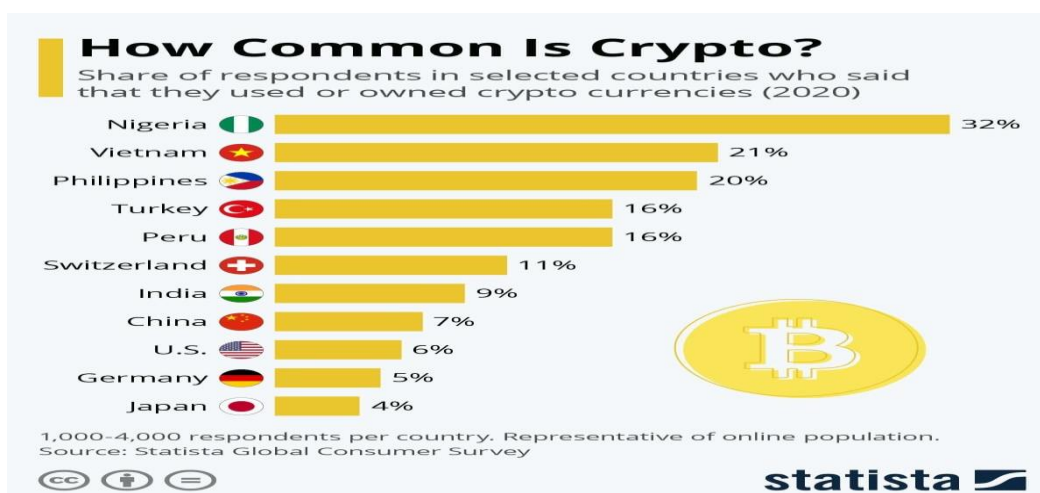


Figure 5: Crypto ownership trend as comparative percentage of user of different countries²²⁷

Crypto wallets offer a secure and confidential means of protecting cryptocurrencies, providing an appealing alternative to centralized exchanges that are susceptible to hacking and cyber threats. With the evolving landscape of cybersecurity risks, there is an expected

enduring demand for robust crypto wallet solutions. The rapid growth of the Decentralized Finance (DeFi) ecosystem is a significant catalyst for the expansion of the crypto wallet market. DeFi platforms rely on smart contracts, and crypto wallets are a vital tool for users to effectively engage with these decentralized applications.²²⁸ DeFi's rising popularity, particularly for activities like lending, borrowing, and trading, has substantially increased the need for crypto wallets that seamlessly integrate with these platforms. Additionally, the widespread use of Non-fungible Tokens (NFTs) has left a profound impact on the market.²²⁹ Furthermore, the global remittance market is playing a role in driving the growth of crypto wallets. Cryptocurrencies are increasingly chosen for cross-border money transfers due to their cost-efficiency and swifter processing compared to traditional financial institutions. Crypto wallets play a crucial role in enabling these transactions, permitting users to send and receive digital currencies across borders with minimized fees and expedited processing times.²³⁰ Some of the top cryptocurrencies, in addition to Bitcoin, include Ethereum (ETH), Tether (USDT), XRP, Binance Coin (BNB), USD Coin (USDC), Cardano (ADA), Solana (SOL), Dogecoin (DOGE), Tron (TRX), Polygon (MATIC), and more.²³¹

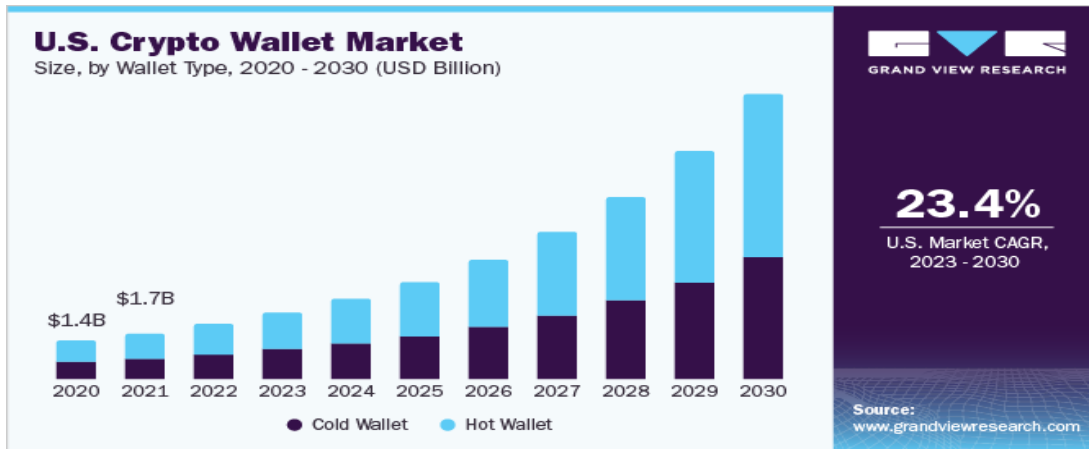


Figure 6: Forecast of U.S. cryptocurrency wallet market²³²

Furthermore, the market for crypto wallets is being significantly influenced by regulatory advancements. Governments and regulatory authorities are taking steps to establish guidelines and prerequisites for crypto wallet providers. These measures are aimed at improving security measures and mitigating risks associated with illicit activities like money laundering and fraud. Compliance with these regulations has become a vital aspect for wallet providers to instill trust and attract users. A notable challenge facing the market is the intricate and technical nature of cryptocurrencies and blockchain technology.²³³ The complexities involved in managing private keys, public addresses, and wallet security can be daunting for many potential users. This intricacy can act as a deterrent for newcomers who wish to enter the cryptocurrency space and utilize crypto wallets.²³⁴ To overcome this challenge, wallet providers and the industry as a whole must prioritize user education and develop user-friendly designs. Wallets should be designed with intuitive interfaces, clear instructions, and robust customer support to guide users through the process of securely setting up and using their wallets. Moreover, in 2020, Bitcoin, one of the most renowned cryptocurrencies, experienced a 500% surge in value over six months. The cryptocurrency market is currently witnessing its longest-lasting bull run.²³⁵ The increasing adoption of cryptocurrency during the pandemic can be attributed to expanding internet penetration, digitalization, rapid technological advancements, and declining trust in traditional financial systems. The rising preference for cryptocurrency during the COVID-19 pandemic is a positive sign for the market's growth.

The crypto wallet market can be characterized as highly fragmented. Key players are implementing a variety of strategic initiatives, including product launches, mergers and acquisitions, partnerships, collaborations, and geographical expansions, to solidify their position in the market and gain a competitive advantage.²³⁶ These prominent players are harnessing the advances in blockchain technology and diversifying their offerings to include crypto assets such as Non-Fungible Tokens (NFTs). Technological innovations driven by these market leaders are expected to propel the industry's growth. Companies are focused on launching new services with innovative features to capture a larger customer base in the market.²³⁷ For example, in August 2023, Ledger announced a strategic partnership with PayPal, marking a significant step towards streamlining cryptocurrency transactions. This partnership would integrate Ledger Live software with PayPal, enabling verified U.S. residents to seamlessly purchase cryptocurrencies like Bitcoin, Ether, Bitcoin Cash, and Litecoin via Ledger Live, eliminating the need for additional verification processes.²³⁸ Some of the prominent players in the

global crypto wallet market include Coinbase Global, Inc., BitGo, Binance, BitPay, SatoshiLabs s.r.o. (Trezor), Ledger SAS, BlockFi Inc., Exodus Movement, Inc., ZenGo Ltd, Crypto.com, Blockchain.com, Inc., and others.²³⁹

The world's first comprehensive report, focusing on crypto retail users worldwide, has delved into data from over 61,000 crypto enthusiasts, providing valuable insights into their motivations, behaviors, and preferences. According to the findings, there exists an almost unanimous confidence in cryptocurrencies, with 97% of users expressing trust in them. Over half of these users (52%) perceive crypto investments not as a pastime but as a means of generating income, and for 15% of them, cryptocurrencies serve as their primary income source. Furthermore, the top three reasons that drive users to invest in cryptocurrencies include owning crypto as part of a long-term investment strategy (55%), harboring distrust in the current financial system (38%), and capitalizing on short-term trading opportunities (31%). Retail investment in cryptocurrencies is on the rise across the globe.²⁴⁰ As cryptocurrencies have become more accessible through various platforms like Paypal, LocalBitcoins, Grayscale, Binance, and others, it has become increasingly crucial to comprehend the dominant user profiles and their associated preferences. Prior to this report, there has been a scarcity of unbiased investigations into the motivations, behaviors, and preferences of this burgeoning global audience.²⁴¹

The anticipated growth of the bitcoin blockchain technology market is projected to reach \$50 billion by 2026, with 60% of its overall value concentrated within the financial sector. Each day, an impressive 30,000 social media posts related to bitcoin surface online, equivalent to around 1500 posts per hour or approximately 30 posts per minute. Tether is poised to become one of the largest crypto assets as of February 2022, boasting a substantial \$109 billion in trading volume. Ethereum is expected to achieve roughly 10 million daily bitcoin transactions by 2025, marking a significant milestone for Bitcoin's primary competitor. In Q3 of 2021, Ethereum claimed the title for the highest number of daily crypto transactions, surpassing Bitcoin. Ethereum averaged 2.4 million bitcoin transactions per day, while Bitcoin managed around 500,000. Moreover, by March 2030, a staggering 14 million new instances of crypto malware are predicted to emerge. The global cryptocurrency market's total value in 2020 was approximately \$1,000 million, and it is forecasted to experience a robust CAGR of 30%, ultimately reaching approximately \$5,190.62 million by 2026. On a more conservative estimate, the market size was \$1,500 million in 2020 and is likely to grow to \$1,758 million by 2027, representing an 11.2% CAGR. The total cryptocurrency market's value is on track to increase by nearly 1800% from March 2021 to February 2022.²⁴² However, the underlying reasons behind the widespread use and immense popularity of cryptocurrency have been summarized and presented in Figure 7.

Why People Invest in Cryptocurrency

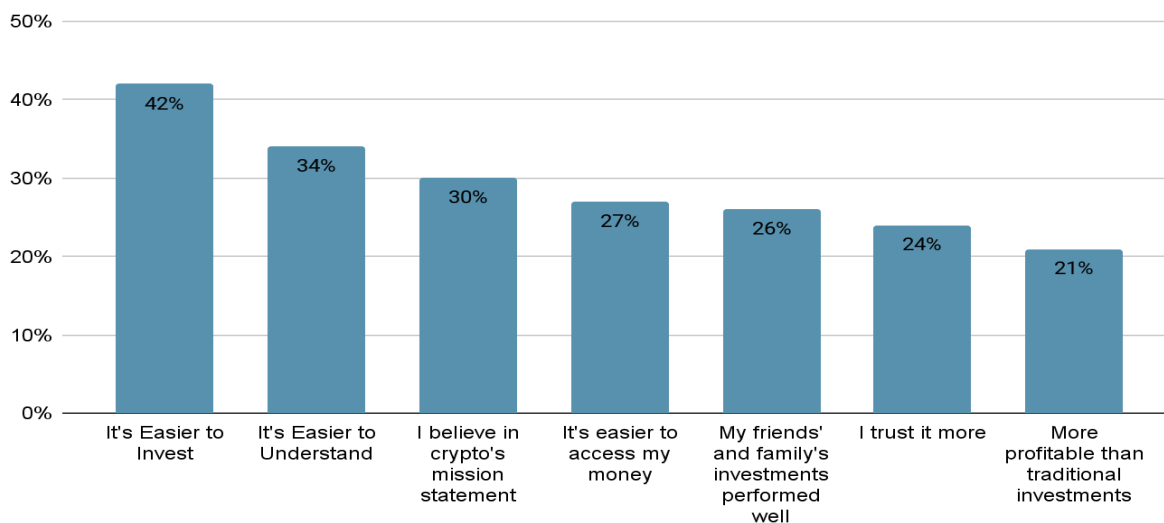


Figure 7: Important reasons for use cryptocurrency by modern population²⁴³

Regulation, Challenge and Future of Cryptocurrency

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In 2014, the World Bank published a report stating that bitcoin was not intentionally designed as a Ponzi scheme.²⁴⁴ Additionally, the Swiss Federal Council investigated concerns in the same year that bitcoin might resemble a pyramid scheme but concluded that, as typical promises of profits were absent in the case of bitcoin, it could not be categorized as a pyramid scheme.²⁴⁵ The European Central Bank attributed the decentralization concept of bitcoin to the Austrian school of economics, especially influenced by Friedrich von Hayek's work in "Denationalization of Money: The Argument Refined."²⁴⁶ Hayek advocated for a completely free market in money production, distribution, and management to challenge the monopoly of central banks.²⁴⁷ The New York Times reported that libertarians and anarchists were initially drawn to the philosophical underpinnings of bitcoin. Early bitcoin supporter Roger Ver highlighted that many early adopters joined the movement for philosophical reasons, seeing bitcoin as a means to separate money from state control.²⁴⁸ The Economist characterized bitcoin as a techno-anarchist initiative to create a digital version of cash, enabling transactions free from government or bank interference.²⁴⁹ Economist Paul Krugman, however, argued that cryptocurrencies like bitcoin have developed something of a cult following rooted in paranoid fantasies of government power.²⁵⁰ The legal status of bitcoin varies significantly from one country to another and remains undefined or subject to change in many places. Regulations and prohibitions that apply to bitcoin often extend to similar cryptocurrency systems.²⁵¹ Due to its decentralized nature and global trading on online exchanges, regulating bitcoin has been challenging. Criminalizing the use of bitcoin and shutting down exchanges and peer-to-peer networks within a country can effectively function as a de facto ban.²⁵² Academic research published in the Journal of Monetary Economics found evidence of price manipulation during the Mt. Gox bitcoin theft, revealing vulnerabilities to market manipulation.²⁵³ The history of hacks, fraud, and theft related to bitcoin can be traced back to at least 2011.²⁵⁴ Research by John M. Griffin and Amin Shams in 2018 suggested that trading connected to the Tether cryptocurrency²⁵⁵ and activity at the Bitfinex exchange contributed to roughly half of the late 2017 bitcoin price surge.²⁵⁶

According to the Library of Congress²⁵⁷, nine countries, including Algeria, Bolivia, Egypt, Iraq, Morocco, Nepal, Pakistan, Vietnam, and the United Arab Emirates, impose an "absolute ban" on trading or using cryptocurrencies. An "implicit ban" is enforced in 42 other countries, such as Bahrain, Bangladesh, China, Colombia, the Dominican Republic, Indonesia, Kuwait, Lesotho, Lithuania, Macau, Oman, Qatar, Saudi Arabia, and Taiwan.²⁵⁸ On October 22, 2015, the European Court of Justice ruled that bitcoin transactions would be exempt from Value Added Tax.²⁵⁹ The U.S. Commodity Futures Trading Commission has issued four "Customer Advisories" concerning bitcoin and related investments,²⁶⁰ emphasizing the speculative nature of cryptocurrency trading and associated risks of hacking and fraud in a July 2018 warning. In May 2014, the U.S. Securities and Exchange Commission cautioned that investments involving bitcoin could be susceptible to high levels of fraud²⁶¹ and that investors might encounter solicitations on social media platforms.²⁶² An earlier "Investor Alert" had warned about the use of bitcoin in Ponzi schemes.²⁶³ In 2013, the European Banking Authority raised concerns about the lack of bitcoin regulation, the potential for exchange hacks, bitcoin price volatility, and the risk of fraud.²⁶⁴ Both FINRA and the North American Securities Administrators Association have issued investor alerts regarding bitcoin.²⁶⁵



Figure 8: Cryptocurrency is a threat to traditional banking system²⁶⁶

In June 2021, the Legislative Assembly of El Salvador passed a law making bitcoin legal tender alongside the US dollar.²⁶⁷ This legislation became effective on September 7, making El Salvador the world's first country to do so.²⁶⁸ However, the implementation of this law sparked protests²⁶⁹ and calls to make the use of cryptocurrency optional rather than mandatory.²⁷⁰ A survey conducted by the

Central American University revealed that the majority of Salvadorans disagreed with the use of cryptocurrency as legal tender.²⁷¹ Additionally, a survey by the Center for Citizen Studies (CEC) indicated that 91% of the country's population preferred using the US dollar over bitcoin.²⁷² As of October 2021, the Salvadoran government was exploring bitcoin mining using geothermal power and issuing bonds tied to bitcoin.²⁷³ A Central American University survey conducted 100 days after the bitcoin law came into effect found that 34.8% of the population had no confidence in bitcoin, 35.3% had little confidence, 13.2% had some confidence, and 14.1% had a lot of confidence in the cryptocurrency. Among the respondents, 56.6% had downloaded the government's bitcoin wallet. Of those, 62.9% had never used it or had used it only once, while 36.3% used bitcoin at least once a month.²⁷⁴ In 2022, the International Monetary Fund (IMF) urged El Salvador to reverse its decision after bitcoin's value dropped by half in just two months. The IMF also warned that it might be challenging for El Salvador to obtain a loan from the institution.²⁷⁵ According to one report in 2022, 80% of businesses refused to accept bitcoin despite being legally required to.²⁷⁶

In the realm of cryptocurrencies, criminal use has drawn the attention of financial regulators, legislative bodies, law enforcement agencies, and the media.²⁷⁷ Some news outlets have claimed that the appeal of bitcoin lies in its potential to be used for illegal purchases.²⁷⁸ Nobel Prize-winning economist Joseph Stiglitz has asserted that bitcoin's anonymity fosters money laundering and other criminal activities.²⁷⁹ Moreover, the environmental impact of bitcoin is a subject of concern.²⁸⁰ Bitcoin mining consumes significant energy and is associated with electronic waste accumulation. The process generates carbon emissions, primarily from power plants running on gas and coal. This contributes to the cryptocurrency's negative environmental effects, and as of 2022, it's estimated to be responsible for 0.1% of global greenhouse gas²⁸¹ emissions.²⁸² Bitcoin mining also relies on specialized computer equipment with a relatively short lifespan.²⁸³ In 2021, it was estimated that bitcoin mining produced 30,000 tonnes of annual electronic waste, equivalent to the Netherlands' e-waste production.²⁸⁴ The original creator of the bitcoin client framed their software's authorship as a means to demonstrate the validity of the concept of purely peer-to-peer electronic cash and the feasibility of a paper with solutions. Wladimir J. van der Laan assumed the role of lead developer on April 8, 2014.²⁸⁵ Bitcoin Core was central to a dispute in 2015 with bitcoin XT, a competing client aiming to increase the block size.²⁸⁶ The development of Bitcoin Core is supported by over a dozen different companies and industry groups. On March 25, 2014, the United States Internal Revenue Service (IRS) determined that bitcoin should be treated as property for tax purposes, subjecting virtual currencies to capital gains tax.²⁸⁷ Cryptocurrency networks' lack of regulation has been criticized for enabling criminals to evade taxes and launder money.²⁸⁸ The Financial Action Task Force (FATF)²⁸⁹ defines cryptocurrency-related services as "virtual asset service providers" (VASPs) and recommends regulating them with the same anti-money laundering (AML) and know your customer (KYC) requirements as financial institutions²⁹⁰. The European Commission introduced a digital finance strategy in September 2020,²⁹¹ which included a draft regulation on Markets in Crypto-Assets (MiCA) designed to establish a comprehensive regulatory framework for digital assets in the EU. On June 10, 2021, the Basel Committee on Banking Supervision²⁹² proposed that banks holding cryptocurrency assets must set aside capital to cover potential losses, requiring them to hold capital equal to the full value of their cryptocurrency holdings. While cryptocurrencies have experienced substantial fluctuations, the IMF is advocating for a coordinated, consistent, and comprehensive approach to cryptocurrency supervision. Tobias Adrian, the IMF's financial counselor and head of its monetary and capital markets department, expressed in a January 2022 interview that establishing global regulations is a complex process but essential for maintaining financial stability and harnessing the benefits of technological innovations in the sector.²⁹³

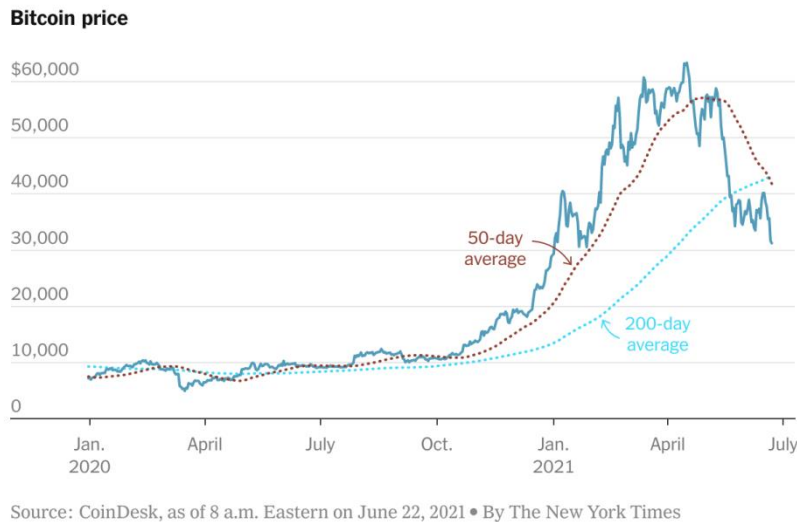


Figure 9: Bitcoin price fluctuation shown in graph in 2021-22²⁹⁴

In 2021, regulations and resolutions regarding cryptocurrency were enacted in 17 U.S. states.²⁹⁵ The U.S. Securities and Exchange Commission (SEC)²⁹⁶ is currently deliberating on its course of action. On July 8, 2021, Senator Elizabeth Warren, a member of the Senate Banking Committee, penned a letter to the SEC chairman, seeking clarification on cryptocurrency regulation due to the growing use of cryptocurrency exchanges and its potential risks to consumers. Responding to Senator Elizabeth Warren's letter on August 5, 2021, SEC Chairman Gary Gensler emphasized the need for legislation focused on "crypto trading, lending, and DeFi platforms." He expressed concerns about the vulnerability of investors trading on cryptocurrency platforms without a broker. Gensler also pointed out that many tokens in the crypto market could be unregistered securities without the necessary disclosures or market oversight. On March 23, 2023, the U.S. SEC issued an investor alert, noting that firms offering crypto asset securities may not be adhering to U.S. laws, potentially omitting essential information.²⁹⁷ In September 2017, China prohibited initial coin offerings (ICOs), leading to an initial decrease in cryptocurrency returns during the announcement. However, the liquidity effect eventually became positive post-news.²⁹⁸ On June 27, 2021, the UK's financial regulator demanded that Binance, the world's largest cryptocurrency exchange,²⁹⁹ cease all regulated activities in the UK.³⁰⁰ As of now, India neither explicitly prohibits nor allows cryptocurrency market investments.³⁰¹ In 2020, the Supreme Court of India lifted the cryptocurrency ban imposed by the Reserve Bank of India.^{302,303} On April 30, 2021, the Central Bank of the Republic of Turkey banned the use of cryptocurrencies and cryptoassets for making purchases, citing significant transaction risks.³⁰⁴

The increased accessibility and user-friendly platforms available for bitcoin investments have significantly contributed to the growing interest among retail investors. The abundance of cryptocurrency exchanges and investment apps has simplified the process of buying, selling, and storing digital assets, making it more straightforward for retail investors to enter the bitcoin market. These platforms offer user-friendly interfaces, educational resources, and a variety of payment options, further lowering the entry barrier for retail investors. The potential for substantial profits has always made cryptocurrency investments enticing. In 2023, retail investors have witnessed significant returns in the cryptocurrency market, particularly during periods of market volatility. The substantial growth of cryptocurrencies like bitcoin and Ethereum over the years has generated a sense of FOMO (Fear of Missing Out) among retail investors, drawing them into the cryptocurrency market³⁰⁵ with the promise of substantial gains.

The landscape of cryptocurrency regulation has been gradually evolving, introducing more stability and clarity. Governments and financial regulatory bodies have initiated the development of structures and guidelines for managing cryptocurrencies. This increasing regulatory stability has instilled greater confidence in retail investors, alleviating concerns about potential legal and compliance issues. The growing legitimacy of the bitcoin market has attracted a broader range of ordinary investors who seek regulated and secure investment opportunities. As cryptocurrencies become more integrated into traditional financial systems, their adoption is expected to expand. Notably, significant financial institutions, including banks and investment firms, have started offering cryptocurrency-related

services such as custody, trading, and investment products. This bridge between conventional finance and the cryptocurrency market enhances the industry's credibility and accessibility to everyday investors. The acceptance of cryptocurrencies as a payment method by major retailers and online platforms has further piqued the interest of retail investors. The impact of social media and online forums in fueling interest in cryptocurrencies among retail investors is undeniable. Platforms like Twitter, Reddit, and cryptocurrency-specific forums have become hubs for discussions, news, and investment advice. Influential figures and celebrities endorsing cryptocurrencies on social media have had a significant impact on shaping the perspectives of regular investors. The ease of access to information, the ability to connect with like-minded individuals, and the capacity to stay informed about market developments through social media have collectively contributed to the growing enthusiasm and interest of retail investors in cryptocurrencies. For an overview of cryptocurrency crime statistics, including the number of heists and the amount stolen over time (2017-22), please refer to Figure 10 below.

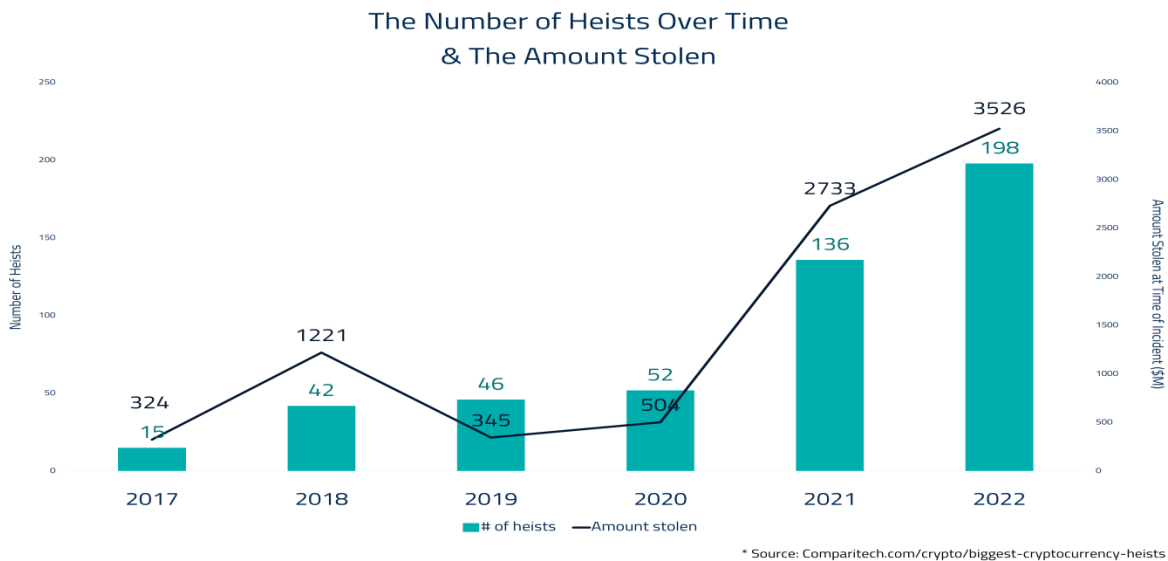


Figure 10: Cryptocurrency crime statistics over time³⁰⁶

Presently, retail investors are actively seeking alternative investment avenues to serve as a protective buffer against the traditional market uncertainties triggered by global economic instability and inflationary pressures. In response to these concerns, cryptocurrencies have witnessed a surge in popularity as a potential hedge against both inflation and economic downturns. They are often regarded as a reliable store of value, often referred to as 'digital gold'. Retail investors are increasingly turning to cryptocurrencies as a strategy to diversify their investment portfolios and shield their wealth from the erosion of fiat currencies. A key driver of retail investor interest in cryptocurrencies is the constant stream of technological advancements and innovations within the cryptocurrency market. The rise of non-fungible tokens (NFTs), decentralized finance (DeFi) platforms, and blockchain-based applications has highlighted the transformative potential of cryptocurrencies. Retail investors are eager to participate in this technological revolution, recognizing the opportunities it presents for financial inclusion,³⁰⁷ peer-to-peer transactions, and distinctive investment prospects. As interest in cryptocurrencies continues to grow, there is a wealth of educational resources available to retail investors. They have access to a wide range of learning materials, including online courses, tutorials, and educational publications, which empower them to comprehend the fundamentals of cryptocurrencies and blockchain technology. Additionally, extensive media coverage and financial news outlets regularly spotlight the achievements and developments in the cryptocurrency market, contributing to greater awareness and kindling the interest of individual investors.

It's vital to acknowledge that the heightened appeal of cryptocurrencies to retail investors is influenced by the market's speculative nature and a certain degree of risk appetite. Investing in cryptocurrencies carries inherent volatility and risk, potentially resulting in substantial losses. The fast-paced and dynamic environment of the cryptocurrency market is attractive to retail investors who are willing to take calculated risks in pursuit of potential rewards. While some may perceive retail investors' interest in cryptocurrencies as a quest for quick profits, many investors possess a deeper comprehension of how cryptocurrency projects aim to revolutionize daily life, foster financial inclusion, and promote independence. At its core, cryptocurrency represents a technology that facilitates decentralized, secure,

and transparent transactions without the need for intermediaries, such as traditional banks or financial institutions. This translates to individuals being able to conduct direct peer-to-peer financial transactions, eliminating the need for costly and time-consuming intermediaries. This is of particular significance to those without access to conventional banking services or those underserved by the existing financial system. The interest of retail investors in cryptocurrency is not solely rooted in the allure of rapid financial gains. Numerous investors view cryptocurrency as a means to attain financial independence and, ultimately, to contribute to the cause of financial inclusion. They recognize that the underlying technology of cryptocurrency holds the potential to disrupt conventional financial systems, rendering them more accessible and transparent. Figures illustrating the global adoption and ownership of cryptocurrencies have been presented in Figure 11, which is located below. Additionally, a graphic depicting the trend in cryptocurrency ownership as a percentage of different countries' populations around the world can be found below Figure 12.



Figure 11: Global crypto ownership and adoption statistics³⁰⁸

Consequently, numerous cryptocurrency projects are dedicated to advancing financial inclusion by extending banking services to individuals without access or with limited access to traditional banking. Leveraging blockchain technology, these initiatives construct decentralized financial ecosystems that are open to anyone with an internet connection. By offering financial services to those who have been marginalized by the conventional financial infrastructure, these endeavors strive to encourage financial inclusion and autonomy. Furthermore, a multitude of cryptocurrency projects aspire to revolutionize various sectors, including real estate, healthcare, and supply chain management. These ventures harness blockchain technology to construct secure and transparent systems that outperform traditional systems in terms of efficiency and cost-effectiveness. In addition to furthering financial inclusion and redefining other industries, cryptocurrency offers investors an opportunity to engage in the advancement of an innovative and groundbreaking technology. By investing in cryptocurrency projects, investors contribute to the development of pioneering solutions to some of the most pressing global challenges.

PERCENTAGE OF POPULATION THAT OWNS CRYPTO 2023

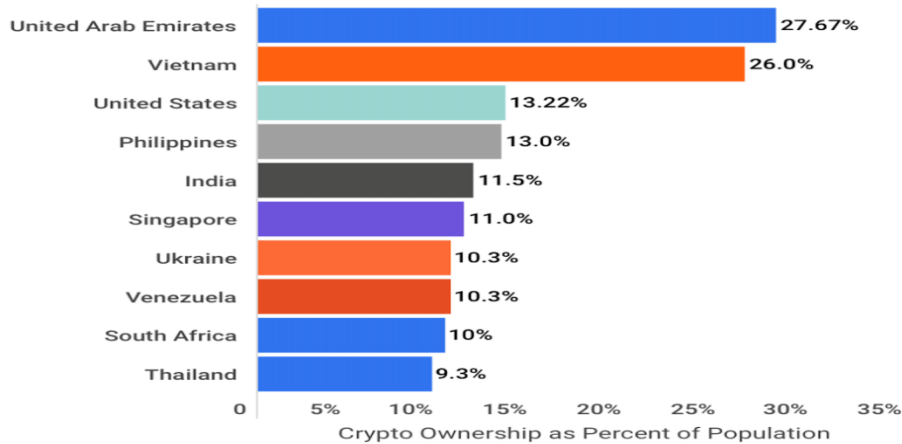


Figure 12: Crypto ownership trend as percent of population of different countries³⁰⁹

Conclusion

The cryptocurrency market has shown remarkable growth, with the total market value expected to surge by nearly 1800% from March 2021 to February 2022. Projections also indicate the potential emergence of 14 million new crypto-related malware instances by March 2030. In 2020, the global cryptocurrency market was valued at approximately \$1000 million, and it's anticipated to sustain a robust compound annual growth rate (CAGR) of 30%, reaching around \$5,190.62 million by 2026. The bitcoin blockchain technology market is predicted to reach \$50 billion by 2026. The journey of Bitcoin, which started in 2010 at \$0.09, has been remarkable, with the current price in 2022 exceeding \$19,000, representing a staggering price increase of 46,449,400% over 11 years. Market analysts speculate that Bitcoin's price may eventually reach a substantial \$100,000. While Bitcoin remains the dominant cryptocurrency with 65% ownership among all crypto users, it now faces competition from the more than 20,000 cryptocurrencies available today. Some of these alternatives, like Ethereum, have experienced substantial growth. The international adoption of cryptocurrencies has been significant, with the number of cryptocurrency users surging by 190% between 2018 and 2020. The United States alone boasts about 45 million crypto users, and there are 420 million cryptocurrency users globally. The number of crypto wallets worldwide has grown remarkably by 1,271.97% since 2016. Cryptocurrency's expansion is still expected to gain momentum, with the global market projected to experience a CAGR of 56.4% between 2019 and 2025. However, this growth is likely to come with increased regulations and government involvement, which is an ironic outcome considering the initial goals of cryptocurrency. Over the past few years, cryptocurrencies have emerged as a potent and relatively new investment asset class, providing remarkable returns. The growing interest in this field comes from various sectors and predicts a continuing trajectory of market growth. In contrast to a decade ago when only tech-savvy, privacy-focused individuals experimented with digital currencies, today's cryptocurrencies are accessible through user-friendly platforms such as Binance, Coinbase, Robinhood, and others. The current total cryptocurrency market cap stands at \$2.79 trillion, making it equivalent to the 8th largest global economy. The presence of 730 global cryptocurrency spot exchanges reflects the market's magnitude. Notably, the New York Attorney General, who was previously a critic, has raised concerns about the US dollar's 100% backing of the crypto coin, implying a potential lack of stability.

The growing interest among retail investors in cryptocurrencies during 2023 can be attributed to a combination of factors, including greater accessibility, the promise of high returns, a developing regulatory framework, market integration, the influence of social media, and technological advancements. Cryptocurrencies have gained acceptance and are being integrated into traditional financial institutions, attracting retail investors seeking opportunities in this new asset class. Nevertheless, retail investors must approach cryptocurrency investments with care, conducting thorough research and being aware of the associated risks. Retail investors can navigate the cryptocurrency market and potentially benefit from its growth and innovations with the right knowledge, risk management strategies, and a long-term perspective. The promise of early adoption and the growth prospects of cryptocurrencies draw in retail investors who recognize that the cryptocurrency market is still in its early stages, offering the potential for substantial gains as it matures. These investors aim to position themselves for long-term growth and hope to profit from the success of new ventures and cutting-edge blockchain technologies. Despite the potential of cryptocurrency and blockchain as distributed, immutable ledger systems, they are

susceptible to attacks by malicious users. While the utility of blockchain technology has expanded from its origins in digital currency to include smart contracts, its security fundamentally relies on cryptography. Although numerous reports and research emphasize the vulnerabilities and security issues associated with cryptocurrency and blockchain, there is a need for comprehensive and systematic surveys from both application and technical perspectives, implying that more study and research are likely in the future.

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