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What data have told us about decentralized finance[☆]

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ABSTRACT

This paper surveys the growing empirical literature on decentralized finance (DeFi), emphasizing how protocol design and incentive structures shape economic outcomes in blockchain-based financial systems. We review evidence on tokens, decentralized exchanges, lending platforms, yield farming, derivatives, governance, infrastructure, and regulation. Across these domains, research highlights mechanisms of liquidity provision, price discovery, leverage, systemic fragility, and investor behavior, as well as vulnerabilities stemming from arbitrage frictions, liquidation dynamics, and maximal extractable value. We also examine the roles of audits, oracle networks, settlement mechanisms, and transparency tools in substituting for traditional oversight. The findings indicate that DeFi replicates many functions of traditional finance while introducing new risks linked to pseudonymity, smart contracts, and composability. The survey concludes by outlining open questions for research and policy on market efficiency, governance, systemic risk, and long-term sustainability.

1. Introduction

The launch of Bitcoin introduced the first working model of decentralized finance by enabling peer-to-peer transactions without intermediaries. Ethereum expanded this foundation by embedding programmable smart contracts, which made it possible to issue tokens, run decentralized exchanges (DEXs), operate lending platforms, and develop a wide range of financial applications. These innovations gave rise to an ecosystem that substitutes legal enforcement and centralized oversight with transparent code execution, incentive design, and user participation. Over little more than a decade, decentralized finance (DeFi) has evolved into a distinct financial architecture with its own market structures, risk channels, and policy challenges.

A rapidly growing empirical literature now examines this transformation. Early work treated cryptocurrencies primarily as speculative assets or alternative payment instruments. More recent studies analyze how protocol design shapes liquidity provision, price discovery, leverage, and governance, and how these mechanisms interact with systemic risk. Empirical research spans topics such as tokenomics and valuation, the functioning of automated market makers in DEXs, collateral dynamics in lending markets, and incentive structures in yield farming and derivatives. The scope has widened further to include non-fungible tokens (NFTs), metaverse economies, and the integration of DeFi with traditional finance.

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Table 1
Blockchain token archetypes.
Source: Adapted from Cong and Xiao (2021), and Oliveira et al. (2018).

Category	Archetype	Primary function	Description
General Payment Token	Wrapped Token	Cryptocurrency Representation	Representation of native tokens used to reward nodes for validating transactions and maintaining network integrity.
General Payment Token	Stablecoin Token	Currency	A token designed for transactions that aims to function as a digital currency.
Cash-Flow-Based Token	Fundraising Token	Fundraising	Used as a financing tool for project development.
Platform Token	Voting Token	Governance	Provides voting rights for platform governance and decision-making.
Platform Token	Payment Token	Internal Transactions	Facilitates payments within a specific application or platform.
Product Token	Work Token	Incentive Mechanism	Rewards users for performing specific actions or contributing to the platform.
Product Token	NFTs	Ownership Representation	Represents ownership of non-fungible physical or digital assets.

At the same time, this literature emphasizes vulnerabilities and externalities. Research documents frictions in arbitrage and cross-market segmentation, systemic risks arising from stablecoins and leverage, and the concentration of decision-making in ostensibly decentralized governance systems. Other studies investigate manipulation, maximal extractable value (MEV), and investor behavior shaped by volatility and speculation. A parallel body of work addresses policy-relevant issues, including taxation, regulatory arbitrage, compliance, and the sustainability of proof-of-work mining.

This survey reviews the empirical findings on DeFi, with a focus on mechanisms that distinguish it from traditional finance. Our focus on empirical papers causes us to omit many great theoretical contributions in the field. The discussion is organized around tokens, decentralized exchanges, lending platforms, yield farming and derivatives, governance and incentives, infrastructure, regulatory frictions, and systemic risk. By synthesizing evidence across these domains, the paper highlights both the economic forces that structure DeFi and the open questions that remain for future research and policy design.

2. Tokens

In blockchain systems, native currencies such as Bitcoin and Ether function as the network's "legal tender". They compensate miners and validators for securing the network and are the exclusive medium for paying transaction fees, since their issuance and transfer are embedded in the protocol. Tokens, by contrast, are digital assets created and managed through smart contracts on programmable blockchains. Unlike native cryptocurrencies, tokens are issued at the application layer and can represent diverse claims and utilities. They are central to decentralized finance because they enable payments, collateralization, governance, and access to services.

To systematize the discussion, we follow Cong and Xiao (2021), who distinguish four broad categories—general payment tokens, platform tokens, product or ownership tokens, and cash-flow-based tokens. For additional granularity, we draw on Oliveira et al. (2018), who identify eight archetypes. Table 1 integrates these perspectives and provides the structure for the subsections that follow.

2.1. Wrapped tokens

Wrapped tokens are smart-contract-based representations of native cryptocurrencies. Because native assets such as Bitcoin or Ether are not compatible with common smart contract standards like ERC-20,[1] they cannot be integrated into most decentralized applications. To enable interoperability, users deposit native assets into a smart contract or with a third party that issues an equivalent "I Owe You" (IOU) token, such as Wrapped Bitcoin (WBTC) or Wrapped Ether (WETH). These tokens circulate within decentralized finance and can be redeemed by withdrawing the underlying asset from the contract.

A similar mechanism exists in centralized exchanges (CEXs), where trading pairs such as BTC/USDT appear to involve native Bitcoin. In practice, exchanges maintain custody of user deposits and settle trades internally by recording IOUs on their ledgers. Unlike in DeFi, where wrapping is transparent and typically collateralized one-to-one, the safety of exchange-issued claims depends on the solvency and trustworthiness of the intermediary. Failures such as the collapse of FTX illustrate the risks of overissued claims and redemption failures.

[1] ERC-20 is the technical standard that defines fungible tokens on Ethereum, making them directly usable in decentralized applications. Native cryptocurrencies do not conform to this standard.

Castillo and Lehar (2024) study blockchain bridges, which issue wrapped claims known as Blockchain Depository Receipts (BDRs). They show that BDRs trade close to parity with their underlying assets in stable conditions but deviate sharply during crises, reflecting default risk. These deviations depend on both the probability of a successful attack and the likelihood of failed recovery.

Johnson and Scharnowski (2025) examine how WBTC contributes to Bitcoin price discovery. Despite representing less than one percent of the total Bitcoin supply, WBTC accounts for a meaningful share of price discovery, with contributions rising during periods of high trading volume and greater DeFi activity. This evidence indicates that wrapped assets are not only representations of native cryptocurrencies but also generate independent information that feeds back into the underlying market.

Wrapped tokens therefore extend the reach of native cryptocurrencies into DeFi, enhancing interoperability across blockchains and applications. Their usefulness, however, comes at the cost of introducing new fragilities, since their stability depends on collateralization practices, bridge security, and redemption mechanisms.

2.2. Stablecoin tokens

Stablecoins bridge blockchain ecosystems and traditional finance by representing fiat currencies or commodities such as gold and silver. They can be broadly categorized into three types: fiat-backed, overcollateralized, and algorithmic. A stablecoin's key function is to maintain a fixed exchange rate, or "peg", against a reference asset, and the mechanisms for doing so differ across these categories.

2.2.1. Fiat-backed stablecoins

Fiat-backed stablecoins, such as USDT and USDC, maintain a one-to-one reserve ratio with their underlying assets, typically cash or short-term government securities. Their stability depends on the quality and transparency of reserves. Liao (2022) show that stablecoins backed by safer assets, such as cash and Treasuries, are less correlated with Ethereum returns than those backed by riskier assets. In times of stress, safer stablecoins like USDC tend to gain market share, while riskier ones contract.

Episodes of turmoil illustrate how shocks from traditional finance transmit into DeFi. Galati and Capalbo (2024) document that the failure of Silicon Valley Bank caused USDC to "depeg", falling below one dollar because part of its reserves were held at the bank. Oefele et al. (2024) show that this shock triggered a flight-to-quality toward stablecoins with safer reserves and into government-backed money market funds.

Maintaining the peg relies on arbitrage: when a stablecoin trades below one dollar, traders can buy and redeem it with the issuer for reserves; when above, they can send fiat currency to the issuer, obtain newly minted stablecoins, and sell them. Lyons and Viswanath-Natraj (2023) show that Tether's migration to Ethereum in 2019 broadened arbitrage access and reduced peg deviations. Ma et al. (2023) highlight a trade-off: decentralized arbitrage improves price efficiency but may amplify run risk, whereas centralized arbitrage dampens first-mover incentives during crises.

Another line of research studies devaluation risk. Eichengreen et al. (2023) estimate that Tether faces a measurable probability of breaking the peg, which rises sharply during systemic stress. Key drivers include Bitcoin volatility, transaction velocity, and redemption pressure. They also show that stablecoin interest rates are driven more by crypto-market sentiment than by conventional monetary policy, drawing parallels between stablecoins and bank runs.

2.2.2. Overcollateralized stablecoins

Overcollateralized stablecoins, such as MakerDAO's DAI, are backed by a diversified pool of digital collateral, including wrapped tokens, governance tokens, and other stablecoins. Because collateral must exceed the value of the stablecoin issued, this design protects against market shocks but ties stability to collateral prices. Kozhan and Viswanath-Natraj (2021) link DAI's peg to Ethereum volatility, showing that sharp declines in collateral values trigger deleveraging, reduce supply, and temporarily push DAI above one dollar. During the March 2020 Ethereum crash, this mechanism produced a substantial premium. MakerDAO later added USDC collateral and introduced the Peg Stability Module (PSM), which allows direct exchanges between DAI and USDC, both of which reduced peg deviations and intraday volatility. These adjustments demonstrate the importance of collateral management and governance flexibility for systemic resilience.

2.2.3. Algorithmic stablecoins

Algorithmic stablecoins aim to maintain their peg without direct collateral, instead relying on incentive mechanisms that expand or contract supply. Their fragility was underscored by the collapse of TerraUSD (UST) in May 2022, which erased around $50 billion in value and transmitted instability across DeFi markets. Liu et al. (2023) attribute the failure primarily to Anchor protocol, which promised unsustainably high yields that attracted concentrated deposits and amplified run dynamics. Large investors exited early, while smaller participants bore disproportionate losses. The transparency of blockchain activity accelerated the collapse, since investors could observe redemptions in real time. Uhlig (2022) provide a theoretical model of gradual crashes consistent with these observed patterns.

The literature indicates clear differences across designs. Fiat-backed stablecoins tend to be the most resilient but remain vulnerable to disruptions in traditional finance. Overcollateralized stablecoins offer flexibility but depend heavily on collateral values and governance mechanisms. Algorithmic stablecoins, in contrast, have repeatedly failed to sustain stability. These contrasts underscore that stability in DeFi ultimately depends on how design choices balance resilience, flexibility, and systemic risk.

Table 2
Comparison of ICO, DAICO, IEO, and STO.
Source: Adapted from Myalo and Glukhov (2019).

Fundraising model	Definition & Use case	Advantages	Disadvantages
ICO	Crowdfunding often used by startups for quick and easy fundraising.	Easy to set up, high accessibility, potential for high returns.	High fraud risk, regulatory uncertainty, lack of investor protection, medium liquidity, weak governance.
DAICO	Hybrid of DAO and ICO, with investor-controlled disbursements.	Greater investor protection, decentralized decision-making.	Limited managerial flexibility, requires active investor participation, low-medium liquidity, limited regulation.
IEO	Token sale conducted via centralized exchanges.	Exchange vetting improves security, immediate listing, higher liquidity.	High exchange fees, potential for manipulation, limited access, medium-high regulation.
STO	Tokenized securities fully compliant with regulation.	Strong investor protection, regulatory compliance, increased trust.	Costly and complex compliance, slower fundraising process, low liquidity, high regulation.

2.3. Fundraising tokens

Blockchain-based fundraising mechanisms enable issuers to sell tokens that differ in their economic role. Security tokens represent regulated investment products such as shares or bonds. Utility tokens grant access to a service or product within a digital ecosystem. Payment tokens function as a medium of exchange. Myalo and Glukhov (2019) compare the most prominent fundraising models that have emerged in practice: Initial Coin Offerings (ICO), Decentralized Autonomous Initial Coin Offerings (DAICO), Initial Exchange Offerings (IEO), and Security Token Offerings (STO). Table 2 summarizes their main features, advantages, and disadvantages.

Among these mechanisms, empirical evidence is most developed for STOs. Lambert et al. (2022) show that token design and governance features influence outcomes, with voting rights, transparent disclosure, and realistic targets improving fundraising success. In contrast, DAICOs and IEOs have received little empirical attention, and most academic work describes their conceptual potential rather than documenting their performance in practice.

Because of this imbalance, the literature has concentrated primarily on ICOs, which remain the dominant form of token-based fundraising and have generated the largest body of empirical research. For readers seeking a comprehensive overview of this literature, Li and Mann (2021) survey the main empirical findings and highlight how ICOs differ from IPOs by funding early-stage ventures without intermediaries and functioning more like crowdfunding or venture financing. Building on this broader review, the following discussion focuses on three dimensions of the ICO literature: determinants of fundraising success, investor behavior, and post-issuance performance.

2.3.1. Determinants of ICO success

Amsden and Schweizer (2018) identify venture quality and uncertainty as key drivers, showing that well-connected teams and transparent project roadmaps increase success, while high token distribution shares and lack of visibility on platforms such as GitHub reduce it. Bourveau et al. (2022) emphasize the role of disclosure, documenting that ventures providing detailed whitepapers, publishing source code, and engaging actively on social media raise more capital. These effects are amplified when information intermediaries, such as analyst platforms, lend credibility to issuer disclosures. Lyandres et al. (2022) build a comprehensive dataset of more than 7,500 ICOs and find that entrepreneurial “skin in the game” strongly predicts both fundraising success and post-ICO operational performance. Complementing these findings, Lee et al. (2022) show that aggregated analyst ratings improve fundraising outcomes, though Barth et al. (2023) caution that conflicts of interest in reciprocal ratings undermine this disciplining role. This body of work indicates that credible signals and external information production play a central role in mitigating information frictions in a lightly regulated environment.

2.3.2. Investor perspectives and behavior

Using survey evidence, Fisch et al. (2021) show that investors are motivated not only by financial returns but also by technological curiosity and ideological commitment to decentralization, with significant heterogeneity across investor profiles. Momtaz (2020) analyzes a large cross-section of ICOs and finds that while investors earn on average 8.2% on the first day of trading, nearly 40% of ICOs destroy value immediately, reflecting high project risk and susceptibility to adverse shocks such as regulatory bans or hacks. Davydiuk et al. (2023) argue that token retention by issuers serves as a credible signal, reducing information asymmetry and aligning incentives between entrepreneurs and investors. These findings underscore that investor decisions are shaped by a mix of ideological, technological, and financial motives, with information asymmetries amplifying risks in this nascent market.

2.3.3. Returns and post-ICO performance

Benedetti and Kostovetsky (2021) document substantial underpricing in ICOs, with average returns of 179% between the ICO price and the first day of secondary market trading, followed by continued abnormal gains in the first month. Howell et al. (2020) provide evidence that ICOs can finance firm growth, showing that projects whose tokens achieve exchange listings experience higher employment growth and lower failure rates, suggesting that token liquidity has real economic effects. Similarly, Lyandres et al. (2022) find that entrepreneurs' post-ICO commitment, proxied by token retention, predicts stronger operating performance and token adoption. Evidence to date indicates that ICOs yield strong early returns, yet their durability depends on operational execution, the design of token features, and the credibility of the entrepreneurs behind them.

The literature on fundraising tokens therefore reveals a clear divide. Alternative mechanisms such as DAICOs, IEOs, and STOs exist but remain underexplored, with only limited empirical work on their effectiveness. ICOs dominate both practice and research, producing a large body of evidence that highlights a tension between accessibility and risk. They provide unprecedented global reach and liquidity, yet weak governance and disclosure leave investors exposed to fraud, regulatory shocks, and project failure. Success depends critically on credible signals from issuers, alignment of incentives, and effective post-ICO execution.

2.4. Payment tokens

Lo and Medda (2020) classify blockchain tokens into four functional categories. Payment tokens facilitate transactions of goods or services, functioning as digital cash. Utility tokens provide access to a platform's applications or services and are often used to pay transaction fees. Asset tokens represent claims on physical or digital assets, such as commodities or tokenized funds. Yield tokens promise a stream of income, either in the form of profit-sharing rights or other periodic returns, and can resemble equity-like payoffs. These categories are not mutually exclusive, and many tokens combine multiple functions. Their empirical analysis finds that token function is a key determinant of market performance. Payment-only tokens underperform relative to hybrid payment-utility tokens, with the latter displaying greater price resilience. Their results also show that Ether is the dominant driver of token valuations: a 100% change in Ether's price translates into roughly a 73% change in token prices, while Bitcoin has little explanatory power. Other design features, such as staking requirements, sole-medium-of-exchange rules, and insider allocations, do not produce consistent effects.

Findings indicate that valuation is shaped by general market conditions as well as by token design. Tokens that serve both payment and utility purposes demonstrate stronger resilience, pointing to the importance of functionality in determining performance.

2.5. Work token

Work tokens grant users the right or obligation to perform tasks within a blockchain-based ecosystem, with rewards or influence tied to their contributions. Unlike payment tokens, which serve as a medium of exchange, or governance tokens, which provide voting rights, work tokens incentivize productive activity that supports the operation of the platform. They often overlap with utility tokens, since access to services or influence is conditional on holding and using the token.

Chen et al. (2023) study Steemit, a blockchain-based social media platform that rewards content creation with tokens. They show that token price volatility increases user activity but reduces content quality. Higher volatility leads to more frequent posting but encourages repetitive, low-effort contributions. The mechanism operates partly through a shift in user preferences away from Steem Power, an illiquid governance token representing long-term influence, and toward liquid tokens such as Steem or Steem Dollars that provide immediate returns. While the increase in activity dissipates quickly, the decline in quality persists, suggesting that volatility promotes short-term engagement at the expense of sustained value creation.

A related perspective is provided by Ahsan and Gupta (2023), who analyze behavior on Axie Infinity, a play-to-earn platform where in-game tokens — Small Love Potions (SLP) and Axie Infinity Shards (AXS) — carry real-world value. They document that players continue participation despite uncertainty in both gameplay rewards and token prices, motivated by optimism, sunk cost considerations, and perceptions of fairness in reward sharing. Engagement is further sustained by peer networks, game updates, and accumulated skills, which often delay token-to-fiat conversion as users wait for more favorable conditions.

These studies highlight that work tokens embed strong behavioral dynamics. By tying rewards to activity, they can sustain user engagement but also create volatility-driven distortions, raising questions about long-term value creation in gamified or work-based token economies.

2.6. Non-fungible tokens (NFTs)

Non-fungible tokens (NFTs) are blockchain-based tokens that certify unique ownership of a digital asset. Unlike fungible tokens, which are interchangeable, NFTs are distinct and indivisible, making them suited for digital art, collectibles, gaming assets, and metaverse applications. Their distinctiveness also underpins financial uses, as in decentralized finance protocols where NFTs encode liquidity positions or collateral claims.

Unlike fungible tokens, NFTs exhibit heterogeneous attributes, illiquid trading patterns, and strong cultural dimensions, complicating their economic analysis. This section surveys empirical research on NFTs across five themes: behavioral patterns in demand, market microstructure and manipulation, platform and token design, interactions with physical markets, and asset pricing dynamics.

2.6.1. Behavioral research

A growing literature emphasizes the role of social signaling and strategic behavior in NFT markets. Oh et al. (2023) conceptualize NFTs as digital Veblen goods, where demand depends on collective perceptions of desirability. Studying Ethereum-based collections, they document strongly bimodal outcomes: projects either sell out entirely or attract little interest, consistent with coordination on whether a collection is "in" or "out". Issuers respond by underpricing initial sales, or "mints", which generates a mint premium that scalpers exploit by quickly reselling NFTs on secondary markets. This mechanism parallels pricing strategies in other markets for social goods, such as concert tickets and luxury fashion.

Expanding to secondary markets, Lundy et al. (2024) show that NFT demand is shaped by two conspicuous consumption channels. The bandwagon effect raises demand with popularity, while the snob effect reflects demand for rarity or uniqueness. The bandwagon effect is reinforced by wealth and community affiliation, while the snob effect is strongest in profile-picture (PFP) collections, where interpretable rarity traits matter more than abstract visual distinctiveness. Huang and Goetzmann (2023) examine behavioral biases such as selection neglect and extrapolative beliefs during the 2021–22 NFT bubble. Barbon and Ranaldo (2023) link investment returns to wallet characteristics, finding that sophisticated investors outperform average holders.

Social signaling also shapes philanthropic contexts. Liang et al. (2024) study a large NFT charity fundraiser and find that donors who quickly re-list charity NFTs suffer reputational penalties: their other NFTs lose value, especially when their wallets are highly visible. By contrast, donors who hold charity NFTs avoid penalties and may benefit reputationally. An experiment confirms that rapid re-listing is perceived as opportunistic, reducing willingness to transact with the donor.

These studies indicate that NFT demand is shaped as much by social and reputational considerations as by economic fundamentals. Community affiliation, perceptions of fairness, and status signaling amplify volatility and foster speculative cycles that distinguish NFTs from conventional assets.

2.6.2. Market microstructure

NFT markets exhibit distinctive microstructural dynamics, shaped by manipulation, pricing mechanisms, speculative behavior, and governance. Oh (2024) study two forms of manipulation: wash trading, where traders buy and sell the same NFT to inflate volume, and insider trading, where privileged buyers act on non-public information. Wash trading accounts for significant volume but has little effect on prices or liquidity, suggesting motivations linked to marketplace reward schemes rather than price manipulation. By contrast, insider trading has stronger effects: wallets receiving free NFTs from creators consistently predict future price increases. Information also spreads through community ties, as non-insiders embedded in social networks anticipate price movements.

The pricing of virtual land illustrates how NFT markets combine economic fundamentals with speculative dynamics. Goldberg et al. (2024) show that in Decentraland, a blockchain-based virtual world, parcels near focal points command higher prices, mirroring spatial patterns from physical real estate. Yet fundamentals can be overtaken by speculation. Kawai et al. (2025) document that distance-based pricing patterns broke down during the 2021 boom, with later valuations decoupling from fundamentals and many late entrants incurring losses. This cycle highlights how NFT values oscillate between attention-driven fundamentals and speculative excess, creating redistribution of wealth and risks for inexperienced investors.

Governance further shapes market outcomes. Goldberg and Schär (2023) analyze voting in Decentraland's decentralized autonomous organization (DAO), finding that nearly one-quarter of proposals are effectively decided by a single large holder. Strategic interventions by dominant participants undermine collective decision-making, showing how unequal token distributions reproduce power asymmetries despite transparent and forkable governance structures.

Research on NFT market microstructure thus reveals a combination of mechanisms that facilitate information diffusion and price formation, alongside vulnerabilities linked to speculation, manipulation, and concentrated control.

2.6.3. NFT design

Platform design strongly influences creator behavior, user engagement, and market efficiency. Kanellopoulos et al. (2023) analyze "lazy minting", a policy that shifts minting costs from creators to first-time buyers. The change lowered entry barriers and spurred a surge in token creation, especially by repeat users, but at the cost of reduced effort per creation, measured by file quality and metadata. Engagement also declined, with tokens from previously popular creators receiving fewer likes, largely because reduced visibility limited discovery by new audiences. Despite cost savings for creators, primary-market prices did not fall, suggesting that creators captured the subsidy rather than passing it on to buyers.

Some platforms introduced resale royalties, that transfer part of the value increase at every sale to the artist. Tunc et al. (2024) show that when minting costs were eliminated, creators lowered royalty rates, consistent with royalties serving as a way to recover sunk costs. Higher royalty rates reduce liquidity by lowering initial sales prices, prolonging listing times, and decreasing transaction success. Behavioral biases further distort outcomes: some creators anticipating royalty income underprice initial sales but fail to recover losses, consistent with delayed gratification and overconfidence.

These findings demonstrate how platform rules directly shape participation, effort, and income distribution. Policies such as lazy minting and royalties alter both entry incentives and secondary-market liquidity, forcing platforms to balance accessibility for creators against long-term efficiency and sustainability.

2.6.4. NFTs in the broader digital asset ecosystem

Beyond collectibles and virtual goods, NFTs increasingly serve as financial primitives within DeFi. For example, in Uniswap V3, provided liquidity is represented by NFTs, each encoding a unique liquidity position defined by its price interval and capital contribution. This design ties NFT ownership directly to yield generation and market making.

A growing literature situates NFTs within broader asset markets. Borri et al. (2022) construct indices of NFT returns using repeat-sales data across collections. They find average weekly returns of about 2.5% with high volatility and skewness, producing a risk-return profile distinct from both cryptocurrencies and traditional assets. While NFT returns are partially explained by cryptocurrency market movements, most variation remains unexplained, and return predictability patterns resemble those in equity markets. In addition, NFT returns anticipate the performance of NFT-related cryptocurrencies, pointing to spillovers within the broader digital asset ecosystem.

Kanellopoulos et al. (2021) examine interactions with physical collectibles by studying the launch of NBA Top Shot, a blockchain-based platform for basketball highlights. They show that after its introduction, prices for physical basketball cards on eBay declined, particularly for high-quality cards and those featuring active players, consistent with substitution toward digital alternatives. Buyer willingness to pay and seller reservation prices both fell, and transaction volumes declined, only partly offset by new NFT-related activity.

Taken as a whole, the evidence positions NFTs as more than speculative assets. They function as collateral and liquidity instruments in DeFi while also reshaping demand in traditional collectible markets, underscoring their dual role as digital financial primitives and substitutes for existing asset classes.

2.7. Token economic design

Beyond the functional categories of payment, platform, product, and cash-flow-based tokens, a separate body of work examines how economic design features shape token value and performance within DeFi. This literature focuses on incentive mechanisms such as staking, the role of infrastructure like oracle networks, the interaction of governance with collateral stability, and the development of valuation metrics. These studies complement the category-based analysis by highlighting how design choices influence resilience, adoption, and pricing in decentralized markets.

Cong et al. (2022a) develop a dynamic model showing how staking — a mechanism that locks tokens in return for rewards — shapes platform growth and token pricing. Their framework shows that a higher aggregate staking ratio predicts both higher staking rewards, since fewer tokens share the reward pool, and larger price appreciation, as locked tokens reduce circulating supply and encourage participation. These dynamics imply that uncovered interest rate parity is systematically violated in staking-based assets, creating a carry trade that yields excess returns. Empirical analysis across 66 stakable tokens supports these predictions, with the staking ratio positively forecasting short-term token returns and portfolios of high-yield tokens outperforming.

Cong et al. (2023c) examine how decentralized oracle networks (DONs) enhance cross-chain data exchange and stimulate the growth of DeFi ecosystems. Their empirical study of centralized and decentralized oracles shows that DON integration increases user adoption and liquidity, measured through total value locked and market capitalization, and improves resilience to external shocks. By providing reliable price feeds, verifiable randomness, and off-chain data, DONs reduce fragmentation and enable more complex financial applications.

Kozhan and Viswanath-Natraj (2022) analyze MakerDAO's governance token (MKR), showing that its value is tied to the protocol's balance sheet. MKR appreciates when surpluses are used for token repurchases and depreciates when new issuance finances losses. Its volatility is closely linked to ETH collateral volatility, highlighting systemic risks from collateral exposure. Concentration of governance power further weakens incentive alignment and can destabilize the DAI stablecoin.

Liu and Zhang (2023) propose a price-to-utility (PU) ratio as a valuation metric that combines token velocity, staking, and dilution. Using data from major cryptocurrencies, they show that the PU ratio predicts long-term returns more effectively than conventional ratios, with PU-based strategies outperforming benchmarks. The measure links protocol design features to token valuation and provides an empirical anchor for pricing in DeFi markets.

These contributions illustrate how staking incentives, oracle infrastructure, governance design, and valuation models influence the functioning and resilience of tokens within decentralized finance.

2.8. Investor behavior and demand-side dynamics

Research on investor behavior highlights how heterogeneous beliefs and behavioral biases shape demand for cryptocurrencies, with implications for DeFi markets that rely on retail flows and token adoption. Kogan et al. (2024) show that retail investors adopt different strategies across asset classes: they are contrarian in equities and gold but momentum-driven in cryptocurrencies, buying after price increases. This behavior reflects the belief that rising prices signal greater future adoption, reinforcing expectations of continued appreciation.

Benetton and Compiani (2024) use survey data to estimate demand elasticities and find that younger and late-entering investors are systematically more optimistic, a factor that strongly influences portfolio allocations and aggregate market capitalization. Shifts in sentiment among these investors significantly affect total market value, underscoring the role of belief heterogeneity in price formation.

Other studies examine commonality in investor bases. Shams (2022) show that cryptocurrencies co-listed on the same exchanges display stronger comovement in returns, driven less by fundamentals than by shared trading environments and social adoption channels. Natural experiments, such as the 2017 closure of Chinese exchanges, reinforce the role of trading venues and social media in amplifying comovement.

Regulatory shifts also alter demand. Bikunle et al. (2025) study privacy coins such as Monero and ZCash, showing that adoption rises after anti-money laundering regulations targeting exchanges, as investors substitute toward anonymous alternatives. Usage falls when privacy coins are directly restricted or delisted. Case studies of Monero highlight the role of darknet markets in sustaining demand, with different privacy technologies treated as largely interchangeable.

Finally, Gandal and Halaburda (2016) document early competition between Bitcoin and altcoins. Initially, altcoins appreciated faster, but from 2014 onward, Bitcoin's dominance strengthened through network effects that reinforced winner-take-all dynamics. These findings highlight how network externalities and investor sentiment reinforce concentration in leading assets, shaping the liquidity environment for DeFi tokens.

The evidence indicates that crypto investor behavior is driven by momentum strategies, heterogeneous optimism, and responses to regulation. These demand-side forces spill over into DeFi by influencing liquidity conditions, adoption patterns, and systemic vulnerabilities.

3. DeFi institutions

Institutions in decentralized finance (DeFi) differ fundamentally from those in traditional finance because they rely on code-based rules and user participation rather than legal enforcement or centralized oversight. Smart contracts, open-source protocols, and cryptographic verification form the foundations for markets in which exchanges, lending, governance, and settlement operate without intermediaries. This technological basis allows DeFi to replicate core institutional functions — such as issuing money-like assets, facilitating credit intermediation, and coordinating collective decision-making — while embedding them in transparent, automated systems.

The main institutional categories within DeFi mirror the functions of modern financial systems but are implemented through decentralized protocols. Tokens and stablecoins provide the monetary layer, serving as units of account and collateral. Decentralized exchanges (DEXs), often organized through automated market makers, enable trading and price discovery without centralized order books. Lending protocols allow collateralized borrowing and lending, embedding leverage and risk management directly in smart contracts. Derivatives and synthetic asset platforms create opportunities for hedging and speculation on-chain, and decentralized autonomous organizations (DAOs) allocate control over rules and resources. Collectively, these institutions define the architecture of DeFi and provide the framework for the empirical findings reviewed in the following sections.

3.1. Decentralized exchanges (DEXs)

Decentralized exchanges (DEXs) are a foundational component of DeFi, enabling peer-to-peer asset trading without centralized intermediaries. Research has focused on three interrelated areas: liquidity provision, price discovery, and market fragmentation. More recent work also explores performance benchmarking, infrastructure efficiency, and regulatory issues.

3.1.1. Liquidity provision

Liquidity in most DEXs is provided by Automated Market Makers (AMMs), where users known as liquidity providers (LPs) deposit assets into pools that execute trades according to deterministic pricing formulas. Arbitrageurs play a central role in maintaining price alignment between AMMs and external markets.

Most of the research centers around two versions Uniswap and compatible protocols. Uniswap features an AMM that manages liquidity and provides deterministic terms of trade. In Uniswap v2 liquidity is provided for an infinite price range and trading fees are fixed at 30bps. In v3 LPs provide liquidity for a certain price range. Pools can be created at predefined trading fee levels.

Lehar and Parlour (2025) show that in equilibrium, pool depth adjusts so that fee revenue balances adverse selection costs from informed trading. Using data from Uniswap, they confirm that pool size expands with uninformed trading and contracts with volatility. Unlike centralized limit order books, Uniswap's pro-rata fee-sharing mechanism ensures continuous liquidity supply, even during stress events, positioning arbitrageurs as essential for price efficiency and liquidity stability.

Other studies emphasize structural disadvantages faced by LPs. Capponi and Jia (2021a) demonstrate that arbitrage-induced losses can outweigh fee revenues in volatile or illiquid markets, prompting a liquidity 'freeze'. Adoption is more stable when tokens are highly used or have correlated prices, but the curvature of the pricing function creates a trade-off between slippage for traders and arbitrage risk for LPs. Milionis et al. (2022) propose the Loss-Versus-Rebalancing (LVR) metric, which compares LP outcomes to a rebalanced portfolio trading at centralized exchange prices. They find that LVR explains most LP underperformance, and suggest that adaptive fees or oracle-based pricing could mitigate losses. Li et al. (2025) extend this analysis by introducing an option-implied measure of impermanent loss — the opportunity cost of providing liquidity relative to holding assets — which they show commands a risk premium.

The interaction between arbitrage and capital allocation is further studied by Lyandres and Zaidelson (2024), who develop measures of capital allocation efficiency and link them causally to arbitrage activity. Exploiting the Ethereum "Shapella" upgrade, they show that disruptions to arbitrage reduce allocation efficiency, highlighting arbitrage as a mechanism that channels capital to its most productive use.

Large-scale empirical work quantifies LP profitability. Fritsch and Canidio (2024) show that in many high-volume Uniswap v3 pools, fees fail to offset arbitrage losses, while smaller pools often yield positive net returns. They also demonstrate that shorter block times could significantly reduce arbitrage costs, linking blockchain-level design to LP outcomes. Zhu et al. (2024) decompose liquidity into total value locked (TVL) and concentration, showing that volatility, adverse selection, and gas prices reduce both, while fee revenue and token returns increase them. They also document differences between Layer 1 and Layer 2 pools, with the former deeper but more sensitive to gas price shocks.

Settlement rules also shape outcomes. Capponi and Jia (2025) show that up to 96% of arbitrage rents are captured by network validators, who prioritize transactions in exchange for fees. Because arbitrage costs are shared collectively while competition is borne individually, LPs have little incentive to intervene. Mitigations such as faster block times or narrower price ranges reallocate rents among arbitrageurs and validators without improving LP outcomes. Empirical evidence from the Silicon Valley Bank crisis confirms that volatility spikes trigger liquidity withdrawal and changes in pricing curvature.

The evidence therefore portrays AMMs as a mechanism that guarantees continuous trading and enables arbitrage-based price alignment, but at the cost of structural disadvantages for liquidity providers. Profitability and resilience depend heavily on protocol design and blockchain infrastructure, creating trade-offs between liquidity provision, capital efficiency, and rent distribution in decentralized markets.

3.1.2. Market fragmentation

Liquidity in decentralized exchanges (DEXs) is increasingly fragmented across pools, fee tiers, and platforms, shaping the strategies of liquidity providers (LPs). Lehar et al. (2024) show that multiple fee tiers in Uniswap v3 lead to endogenous segmentation. Large, well-capitalized LPs with low gas costs concentrate in low-fee pools, where frequent rebalancing minimizes losses to informed traders and captures high trading volumes. Smaller LPs prefer high-fee pools with lower volumes and less rebalancing, reducing exposure to volatility and high gas costs. Empirically, low-fee pools execute most trades and offer lower price impact, while gas costs strongly influence pool choice and liquidity inflows. Fragmentation thus improves overall market quality by tailoring risk-return trade-offs to different LP clienteles.

Fee-tier fragmentation also affects returns. Adams and Liao (2022) compare Uniswap v3 with its predecessor and show that LPs earn substantially higher fee revenues in v3, especially in volatile pairs at wide fee tiers and in stablecoin pools at narrow fee tiers around the peg. These patterns reflect v3’s flexibility, which allows LPs to concentrate liquidity within chosen price ranges. Although v3 offers higher capital efficiency, v2 remains widely used due to simpler mechanics and lower gas costs, indicating trade-offs between efficiency and usability. Aquilina et al. (2024) document that sophisticated LPs post liquidity in a narrow range around the current price, while retail LPs post on a wider range and rebalance less often.

Fragmentation extends across venues. Aspris et al. (2021) analyze early on-chain order-book DEXs and show that tokens migrating to centralized exchanges (CEXs) lose most of their DEX activity, while overall trading rises and volatility declines. CEXs appear to serve as certification mechanisms that attract risk-averse traders and provide deeper liquidity. Security shocks, such as the Binance hack, temporarily reverse this migration, showing that trust and risk perceptions drive venue choice. DEXs thus play an important role in early token discovery but often serve as stepping stones to centralized markets, reflecting tensions between decentralization and liquidity concentration.

Fragmentation is also evident between blockchain layers. Caparrós et al. (2023) show that large traders and LPs prefer Layer 1 (L1) blockchains like Ethereum, while smaller participants are more active on Layer 2 (L2) solutions such as Polygon, where lower gas costs allow more frequent position adjustments.

In sum, fragmentation enhances flexibility by allowing LPs to self-select into pools and venues that match their strategies, but it also creates coordination challenges that influence liquidity, pricing, and adoption across DeFi markets.

3.1.3. Price discovery

Research on price discovery examines how DEXs incorporate information into asset prices. Klein et al. (2023) compare Uniswap v3 with Binance and show that swap trades on Uniswap have price impacts comparable to market orders on Binance, confirming that decentralized trade flows actively contribute to price formation. They also document that liquidity operations — mints and burns, which adjust pool positions — reveal information when executed near prevailing market prices. Large and strategically timed liquidity events significantly influence prices, indicating that liquidity providers are not purely passive but participate in price discovery alongside traders.

Capponi et al. (2024b) highlight the role of gas fee bidding in transmitting information. In the Ethereum mempool, informed traders often pay higher transaction fees to ensure execution priority. These high-fee transactions have much larger and more permanent price impacts than low-fee trades, reflecting traders’ willingness to pay for immediacy and visibility. The effect persists even after the introduction of private pools, suggesting that some traders prefer transparency and speed to concealment. Gas fees therefore act as a DEX-native mechanism for signaling private information, analogous to limit orders in centralized exchanges.

DEXs also extend price discovery to foreign exchange markets. Adams et al. (2023) study Uniswap transactions between major stablecoins, such as USDC and EUROC, and find that exchange rates track traditional FX benchmarks within a few basis points. Decentralized FX markets offer deep liquidity even on weekends, reduce cross-border transaction costs, and lower settlement and counterparty risks through atomic swaps, which allow simultaneous exchange of assets without intermediaries.

The evidence thus indicates that price discovery in DEXs occurs through both trade flows and liquidity adjustments, with gas fees providing a novel signaling mechanism. Moreover, their influence extends beyond crypto markets, linking decentralized infrastructure to efficiency and accessibility in international finance.

3.1.4. Operational design and data resources in DEX markets

The infrastructure of DEXs differs fundamentally from that of centralized exchanges. Brolley and Zoican (2023) show that while centralized platforms must maintain idle capacity to handle trading surges, DEXs allocate resources dynamically through gas fee bidding. This design produces more intense but shorter bursts of activity, yielding greater cost efficiency. Their model shows that equilibrium spreads depend on relative trader speed rather than absolute latency, suggesting that DEXs can scale efficiently without compromising liquidity.

To support empirical and policy analysis, Chemaya et al. (2023) construct a dataset of Uniswap transactions across Ethereum Layer 1 (L1) and Layer 2 (L2) networks, including Polygon, Arbitrum, and Optimism. They develop daily indices of trading activity, user participation, and decentralization using measures such as entropy, concentration indices, and the Nakamoto coefficient. These metrics allow comparisons of adoption, scalability, and liquidity distribution across networks. An accompanying open-source framework enables replication and customization, making the dataset a key resource for studying DEX evolution and informing regulation.

These contributions highlight how DEX infrastructure achieves scalability through gas fee allocation, while newly available datasets provide the empirical basis for evaluating their efficiency, growth, and resilience.

3.2. Lending and borrowing platforms

Lending and borrowing platforms are among the most widely used applications in DeFi, allowing users to earn yield or obtain leverage by locking collateral in smart contracts. These systems replace traditional intermediaries with algorithmic rules for credit, risk, and capital allocation. Research has examined platform-level decentralization, interest rate dynamics, and liquidation risk.

3.2.1. Liquidity provision and platform decentralization

Cornelli et al. (2024) analyze transaction-level data from Aave V2 to distinguish between depositor and borrower behavior. Depositors primarily seek yield, with participation increasing when traditional interest rates are low, consistent with a search-for-yield mechanism. Retail investors are especially responsive to diminished conventional opportunities. Borrowing is more speculative, often used to leverage positions on expected price appreciation, with some activity linked to governance motives. Larger investors are more likely to borrow to temporarily boost holdings of governance tokens, while retail users mainly pursue yield strategies. Borrowing responds strongly to market sentiment: a 1% rise in the ETH perpetual futures funding rate corresponds to a 0.35% increase in borrowing volume. These results show that DeFi lending reflects both macro-financial conditions and speculative trading strategies.

Zhang et al. (2023) examine the systemic structure of four major protocols — MakerDAO, Compound, Aave, and Liquity — using Ethereum transaction networks. They find that MakerDAO and Compound exhibit more decentralized patterns of fund flows, while Aave and Liquity are more concentrated. Central nodes in these networks often correspond to large centralized exchanges such as Binance, Coinbase, and Huobi, indicating that institutional actors play a dominant role in liquidity provision. Moreover, many of the most connected nodes are externally owned accounts (wallets controlled directly by users or institutions) rather than smart contracts that automatically execute protocol rules. This reliance on a small set of key actors reduces the extent to which lending markets operate through open, automated mechanisms.

The evidence therefore presents a dual picture of DeFi lending: user participation is shaped by macroeconomic conditions and speculative incentives, while systemic outcomes depend on the concentration of liquidity among large institutional actors and exchanges.

3.2.2. Liquidation risk

Liquidation is central to decentralized lending, where borrowers must post collateral worth more than their loans. If collateral values fall below thresholds, smart contracts automatically liquidate positions. Lehar et al. (2022) analyze Compound and Aave and show that liquidations are often executed via flash loans—uncollateralized loans borrowed and repaid within a single blockchain transaction. Flash loans allow liquidators to repay distressed positions instantly, seize collateral, and resell it on decentralized exchanges (DEXs). This process generates price impacts that can trigger feedback loops, where falling prices induce further liquidations. The study also highlights strategic liquidator behavior, including deliberately pushing positions into liquidation to capture arbitrage profits, which amplifies systemic fragility. Tovanich et al. (2025) examine how the network structure between wallets affects liquidation cascades in DeFi lending.

Campello et al. (2023) provide evidence from the Venus protocol, showing that more than half of borrowers maintain loan-to-value (LTV) ratios near the liquidation threshold. A market shock revealed that high-LTV borrowers suffered disproportionately large losses. They also document "zombie debt", loans above liquidation thresholds that persist unresolved. Short-term zombie loans reduce liquidity, while long-term zombies may impose losses on platforms and depositors. Market stress reduces the number of zombie loans but increases their aggregate value, heightening liquidity risk.

Moallemi and Patange (2024) develop a framework to study the trade-off between financing costs and liquidation risk for inattentive borrowers. Using Aave V2 data, they find that over 70% of liquidations occur without preceding price declines, indicating borrower inattention rather than volatility as the primary trigger. Borrowers monitor positions more often than they transact and maintain health factors above model-optimal levels, consistent with conservative behavior. Mueller (2024) add that high gas fees deter smaller users from rebalancing, increasing liquidation risk, and that higher liquidation incentives induce deleveraging among highly leveraged traders.

Heimbach and Huang (2023) analyze leverage across major lending protocols and find that most users employ moderate leverage between 1.4x and 1.9x assets-to-equity, while large and sophisticated users sustain leverage above 2x. Higher leverage correlates with looser LTV requirements, lower borrowing costs, and favorable sentiment, while volatility reduces leverage as borrowers act defensively. At the systemic level, higher leverage raises the share of loans at risk, though liquidations remain event-driven.

These findings suggest that liquidation risk stems not only from market volatility but also from behavioral and structural factors, including borrower inattention, gas fee constraints, and opportunistic liquidator strategies. Collateralization reduces outright default, yet systemic fragility persists through feedback loops, zombie debt, and uneven monitoring capacity.

3.2.3. Interest rates

Research on interest rates in DeFi highlights how both market forces and governance rules shape borrowing costs. Chaudhary et al. (2023a) study Compound and show that traders use DeFi loans to engineer leveraged positions, borrowing stablecoins or volatile tokens depending on market views. Borrowing activity responds to futures premia, but transmission to interest rates is weak: a 1% change in the ETH/USDT perpetual futures premium shifts interest rate differentials by only 0.2–1 basis points. Frictions such as gas fees, price impact, and arbitrage limits dampen the link. Deviations from covered interest parity remain within no-arbitrage bounds once costs are included, and neither interest rate differentials nor futures premia forecast ETH returns.

Governance also shapes interest rate dynamics. Chaudhary et al. (2023b) show that in Compound, borrowing rates depend on utilization (the ratio of borrowed to supplied tokens), with slope parameters voted on by token holders. Volatile assets such as WBTC or ZRX have steeper slopes than stablecoins, so borrowing rates for risky assets rise more sharply as utilization increases. Compound's "kink", which raises rates once utilization exceeds 80%, functions like a buffer requirement in traditional money markets by preserving excess liquidity under stress.

Finally, liquidity mining introduces distortions. Park and Stinner (2023) document "phantom liquidity", where users deposit and borrow the same stablecoin to capture rewards on both sides of the market. These positions inflate total value locked (TVL) without expanding usable liquidity. Phantom liquidity providers (PLPs) accounted for up to 65% of loans and 18% of deposits during peak periods. Their activity depresses borrowing rates and reduces deposit returns, with modest net welfare gains concentrated among a small group of users. While legal and transparent, phantom liquidity distorts interest rate signals and responds sharply to changes in reward design, making interest rate dynamics fragile to incentive shifts.

DeFi interest rates therefore emerge from an interaction of speculative borrowing, governance-driven parameters, and incentive schemes. Collateralization and utilization rules provide stability, but frictions and liquidity mining weaken rate signals and make borrowing costs sensitive to changes in protocol design.

3.3. Third-layer protocols: Yield farming and derivatives

Third-layer protocols in DeFi build on tokens and lending markets to create more complex financial instruments, including yield farming, derivatives, and token-based insurance. These mechanisms extend traditional notions of risk-taking, speculation, and protection.

Augustin et al. (2022) study investor behavior in yield farming on PancakeSwap, where users provide liquidity and receive governance or reward tokens in return. They find strong salience effects: investors disproportionately allocate to farms advertising the highest yields, even though these typically deliver the lowest risk-adjusted returns due to impermanent loss, transaction costs, and operational complexity. Retail users are especially prone to errors, such as failing to stake liquidity provider (LP) tokens, which reduces realized returns. Experiments with third-party dashboards like Yieldwatch show that improved disclosure reduces salience bias and boosts performance, with effects as large as 58%.

Turning to derivatives, Soska et al. (2021) analyze BitMEX, a major centralized exchange for leveraged trading. They document extreme use of leverage — up to 100x — among retail traders, often resulting in forced liquidations during volatility spikes. These liquidations amplify spot market volatility through systemic feedback loops. Sophisticated traders circumvent platform risk controls by splitting activity across multiple accounts, while gamification features such as leaderboards reinforce speculative behavior.

On decentralized derivatives, Andolfatto et al. (2024) show that option prices on blockchain-based platforms exceed those on centralized venues. They attribute this to the design of automated market makers (AMMs), which require overcollateralization for risk management. While these collateral requirements ensure solvency, they also generate capital inefficiencies that raise the cost of on-chain options relative to traditional markets.

The literature on third-layer protocols thus portrays a trade-off. Yield farming can broaden participation but exposes retail users to behavioral biases, while derivatives expand hedging opportunities but amplify volatility and face collateral-related inefficiencies. These dynamics illustrate the tension between innovation and stability as DeFi evolves toward increasingly complex financial products.

4. Infrastructure, incentives, and governance

The functioning of decentralized finance relies on the interplay of technical infrastructure, incentive mechanisms, and governance structures. Protocols operate on blockchain networks that impose unique constraints on settlement, scalability, and transaction ordering, shaping user experience and market outcomes. Incentive design is critical for attracting liquidity providers, securing validator participation, and aligning the interests of stakeholders. Governance arrangements determine how protocols evolve, how risks are managed, and how conflicts are resolved. These elements define the resilience and efficiency of DeFi ecosystems, distinguishing them from traditional finance, which relies on centralized oversight and legal enforcement. This section reviews empirical work on how infrastructure, incentives, and governance interact to support or undermine decentralized financial markets.

4.1. Airdrops

Airdrops are widely used to distribute payment and governance tokens, aiming to bootstrap adoption and encourage early engagement. While effective in attracting attention, empirical evidence shows that they often fail to secure lasting participation.

Messias et al. (2023) analyze several large-scale distributions, including ENS, dYdX, 1inch, Arbitrum, and Uniswap, and find that between one-third and nearly all distributed tokens were quickly sold on exchanges. This rapid selling, largely driven by "airdrop farmers" who maximize eligibility through strategic activity, undermines the goal of fostering long-term users. Even in high-profile cases such as Arbitrum, most claims occurred within a day and were followed by sharp sell-offs. The authors suggest that conditional rewards or fee discounts may align incentives more effectively than unconditional giveaways.

From a broader perspective, Allen et al. (2023) examine a series of prominent cases and identify two core motivations for airdrops: marketing and decentralization. Marketing-oriented airdrops aim to generate initial liquidity and user growth but typically fail to sustain engagement. Decentralization-driven airdrops, which allocate tokens to expand governance participation or reward prior meaningful activity, are more successful in building enduring communities. To capture this dual role, the authors introduce the concept of "dequity", a hybrid instrument that combines financing and governance functions.

Allen (2024) extend this argument by framing airdrops as a coevolutionary process between protocols and users. Drawing on multiple case studies, they show how protocols adapt distribution mechanisms in response to participant behavior. To limit Sybil attacks — where users create multiple identities to maximize claims — and discourage short-term speculation, newer airdrops use multi-round structures, task-based eligibility, and point systems. Under these systems, users earn points for activities such as bridging assets, trading regularly, or participating in governance, while suspicious patterns are penalized. Token allocations are then distributed in proportion to points earned. Arbitrum's airdrop illustrates this model, shifting distribution from passive giveaways to targeted incentives for engagement. Still, recipient behavior remains fluid: opportunistic farmers may evolve into committed participants, while genuine users may act opportunistically.

The literature on airdrops therefore illustrates the tension between marketing and decentralization objectives. As protocols refine distribution mechanisms to reduce speculation and encourage governance participation, airdrops evolve into iterative tools for aligning growth, community building, and long-term sustainability.

4.2. MEV and market frictions

Validators have complete discretion on which transactions to include in a block. They can take advantage of their very short term monopoly power and extract extra revenue, the so Maximal Extractable Value (MEV), by re-ordering transactions in the block, injecting their own transactions at the optimal position, or collecting side payments to include transactions at a certain position. Because pending transactions are visible in the mempool, the public queue of unconfirmed transactions, validators can capture arbitrage opportunities, front run large orders, or insert their own trades ahead of liquidations. MEV has become a central friction in blockchain markets.

Lehar and Parlour (2023) analyze the equilibrium consequences of MEV and model the implications of MEV of the optimal effort choices of seekers to find arbitrage opportunities and thus on market efficiency. MEV allows validators to charge higher fees for seekers that find very profitable trading and arbitrage opportunities, which in equilibrium can lower transaction costs for ordinary users. They document that bots that perform socially desirable activities such as arbitrage to restore price efficiency and liquidations dominate socially harmful bots. Empirically, Capponi et al. (2025) find that validators capture nearly all arbitrage profits, generating inefficient blockspace allocation and user losses exceeding 130,000 Ether. They also show that private relay systems such as Flashbots, which route transactions outside the mempool, mitigate some inefficiencies, though adoption is incomplete because validators have incentives to preserve profitable frontrunning opportunities.

Fee market design further influences settlement dynamics. Easley et al. (2019) model Bitcoin's transition from block rewards to transaction fees, showing how congestion produces an endogenous fee market. Huberman et al. (2021) argue that decentralized competition prevents miners from exercising monopoly power, but Lehar and Parlour (2020) document evidence of miner concentration leading to strategic delays and higher fees. Extending this work, Lehar and Moravvej (2024) show that nearly six percent of Bitcoin transactions bypass the public mempool — the queue of pending transactions — and are settled through private channels. These private arrangements reduce fees and volatility but fragment the settlement process, weakening the assumption of open competition.

On Ethereum, Spain et al. (2020) show that during periods of high demand, such as ICOs, users often overpay fees without faster confirmation, since congestion rather than bidding drives latency. A major reform, Ethereum's EIP-1559, replaced first-price auctions with a mechanism that burns a base fee and allows priority tips. Liu et al. (2022) show that this reduced fee volatility and waiting times but left average fees largely unchanged while increasing the role of MEV in validator revenues. Building on this, Basu et al. (2023) propose StableFees, a uniform-price-inspired mechanism, which simulations suggest would lower volatility in both fees and miner revenues.

A related literature highlights measurement challenges in blockchain data. In UTXO-based systems such as Bitcoin, transactions consume entire units of value and generate "change outputs" that return excess funds to the sender. This accounting method inflates activity metrics. Cole et al. (2022) develop a methodology to distinguish genuine transfers from change outputs, showing that reported transaction volumes are overstated by up to eight times and user counts roughly doubled. Such adjustments are critical for interpreting adoption and usage.

Finally, market microstructure tools have been applied to crypto markets. Easley et al. (2024) show that measures such as the Roll spread, Kyle's lambda, and VPIN retain predictive power for short-horizon return dynamics in Bitcoin, Ethereum, and other major tokens. Their results highlight persistent informational frictions and the central role of BTC and ETH in shaping cross-market behavior.

The evidence as a whole suggests that blockchain systems reduce reliance on intermediaries but introduce new frictions linked to validator incentives, fee design, and data interpretation. MEV lies at the core of these dynamics, influencing both transaction costs and the distribution of rents in decentralized markets.

4.3. Governance, transparency, and protocol incentives

DeFi protocols also differ in governance and transparency, which shape participation, innovation, and market outcomes. Petryk and Li (2024) analyze open-source blockchain software projects and find that decentralized governance attracts greater developer participation and popularity, whereas centralized structures, such as non-profits, are associated with lower innovation. Token-funded projects draw more contributors overall but not higher efficiency per developer, and contributions remain concentrated among a small set of actors, suggesting persistent centralization tendencies. Laturnus (2023) examines 2,377 Ethereum-based DAOs between 2017 and 2022. Her large-sample evidence shows that ownership concentration plays only a minor role in determining performance, while voting participation is the key driver of success.

Auditing is another critical mechanism for transparency. Landsman et al. (2025) examine thousands of smart contract audits and show that protocols are more likely to seek audits when deployed on major blockchains, when offering standardized services such as exchanges or lending, or when using complex data sources. Auditor choice depends on reputation and track record, with decentralized "bounty hunters" emerging as effective reviewers. Audited protocols experience stronger adoption and milder reactions to shocks, although audits do not systematically prevent future breaches, partly because developers switch auditors after exploits. Complementing this, Rabetti (2023) show that audited projects attract rapid adoption, with total value locked (TVL) rising by up to 94% in the first quarter after launch.

Incentives also influence asset pricing. Liu and Tsyvinski (2021) show that returns on over 1,700 cryptocurrencies are primarily driven by adoption, momentum, and attention, while mining costs and traditional valuation ratios matter little. Investor attention, proxied by Google searches and social media, strongly predicts returns. Building on this, Cong et al. (2022b) propose a five-factor model for crypto assets that incorporates market, size, momentum, value, and network adoption. Using data on thousands of tokens, they document a value premium tied to long-horizon reversals and excess returns linked to network growth. The model explains variation across token categories, including payment, platform, and governance tokens, better than equity-based factors. Earlier work by Li and Yi (2018) similarly shows that large-cap and low-volatility tokens outperform others, while conventional proxies such as transaction volume lack predictive power.

Research on governance, transparency, and incentives therefore shows that institutional design, auditing practices, and network-specific pricing dynamics jointly shape DeFi outcomes. Governance affects participation, audits foster adoption while only partly mitigating risks, and valuation hinges more on growth and attention than on traditional financial metrics.

4.4. Infrastructure vulnerabilities and systemic risk

Makarov and Schoar (2022) provide a broad overview of cryptocurrencies and decentralized finance (DeFi), emphasizing both potential benefits and systemic vulnerabilities. They show that economic incentives in proof-of-work (PoW) and proof-of-stake (PoS) systems — mechanisms for validating transactions — tend to concentrate mining or validator power, undermining the vision of decentralization. Smart contracts, while efficient and transparent, are difficult to make fully complete ex ante and lack the legal protections of traditional contracts, raising governance and enforcement challenges. The authors highlight vulnerabilities stemming from interconnected protocols, leveraged positions, and stablecoins, especially as DeFi becomes more integrated with traditional finance.

Makarov and Schoar (2021) complement this perspective with an empirical analysis of the Bitcoin network. They show that most activity is generated by exchanges and custodial entities rather than peer-to-peer payments, and that transaction flows are heavily cross-exchange, limiting the effectiveness of regulatory measures such as Know-Your-Customer (KYC) and Anti-Money Laundering (AML). Mining capacity and coin ownership are highly concentrated, with a small set of actors dominating overall activity. These findings highlight that, despite the narrative of decentralization, Bitcoin's structure depends on a few large players, creating potential systemic and regulatory risks.

The evidence suggests that the resilience of DeFi hinges not only on protocol-level design but also on the concentration of activity within the broader blockchain infrastructure. As integration with traditional finance deepens, these structural features amplify vulnerabilities, underscoring the need for both technical safeguards and effective policy responses.

4.5. Mining, sustainability, and long-term policy implications

Mining economics provide further insights into the long-run sustainability of proof-of-work systems that underpin parts of the DeFi ecosystem. Prat and Walter (2021) develop a dynamic model linking Bitcoin's price to network hashrate—the total computing power securing the chain. They show that free entry caps mining revenues, with most rents accruing to hardware and energy suppliers rather than miners. Their framework accurately predicts hashrate dynamics and highlights how regulation or technological shifts affect both security and environmental impact.

Garratt and van Oordt (2023) extend this analysis by incorporating fixed entry costs, such as specialized hardware purchases. Because these sunk costs discourage miners from exiting during moderate price declines, mining power displays downward rigidity, which strengthens network security by reducing the profitability of double-spending attacks. However, when hardware can be repurposed across coins with low price correlation, smaller cryptocurrencies lose this protection and become more vulnerable.

From a sustainability perspective, Dai et al. (2024) combine industry equilibrium models with climate impact analysis. Their estimates show that Bitcoin mining does not meet established sustainability criteria, with electricity consumption and emissions rising in line with prices despite efficiency gains. These results raise questions about the long-term viability of proof-of-work under climate policy constraints.

This body of work highlights a fundamental trade-off. Mining dynamics enhance security and shape participation incentives, but they also embed systemic fragilities and environmental costs. For DeFi, reliance on PoW-based settlement layers secures transactions in the short run but poses long-term challenges for scalability and sustainability.

5. Risks, crime, and systemic vulnerabilities

Decentralized finance introduces new forms of risk that differ from those in traditional financial systems. The pseudonymous and borderless nature of blockchain transactions creates opportunities for illicit activity, including money laundering, ransomware, and the use of privacy-preserving coins to evade regulation. At the same time, the immutability of smart contracts exposes users to coding errors, governance attacks, and protocol failures that can trigger cascading liquidations and systemic instability. Market manipulation, flash-loan exploits, and maximal extractable value (MEV) illustrate how vulnerabilities emerge endogenously from blockchain infrastructure, blurring the line between strategic behavior and outright abuse. This section surveys the empirical literature on financial crime, operational risks, and systemic fragility in DeFi, emphasizing how technical design, incentives, and regulation interact to shape resilience.

5.1. Crypto-enabled crime and illicit finance

Illicit activity has been central to debates on cryptocurrency adoption. While pseudonymity lowers barriers for crime, public ledgers also allow forensic analysis at an unprecedented scale. Early studies focused on measuring the extent of illegal use, while more recent work examines evolving forms of cybercrime, ransomware, and privacy-preserving infrastructure such as mixers, which pool and redistribute funds to obscure their origin.

Foley et al. (2019) provide one of the earliest systematic estimates of illicit activity in Bitcoin. Combining blockchain records with darknet market data, they estimate that about one-quarter of users and nearly half of transactions were linked to illegal purposes, with annual volumes comparable to global drug markets. Illegal transactions tended to be smaller, more frequent, and clustered within dense networks. The share of illicit activity declined over time as adoption broadened and alternative privacy-focused cryptocurrencies emerged.

Recent work has focused on privacy-enhancing infrastructure. Nadler and Schär (2023) analyze Tornado Cash, a non-custodial Ethereum-based mixer that uses smart contracts and zero-knowledge proofs (zkSNARKs) to obscure transaction linkages. They document over $8 billion in deposits, a mix of legitimate privacy uses and laundering of stolen or sanctioned funds. The authors argue for regulating entry and exit points, such as exchanges, rather than outright bans. Brownworth et al. (2024) study the U.S. sanctioning of Tornado Cash and find that it reduced usage, lowered the governance token price, and led some validators to refuse inclusion of Tornado-related transactions. These findings underscore the tension between privacy and regulatory oversight, with sanctions reducing activity but also fragmenting network consensus.

5.2. Blockchain forensics

A growing literature examines how blockchain transparency enables forensic analysis of illicit finance. Blockchains record all transfers on a permanent ledger, making flows observable even if users are pseudonymous. This dual nature allows both new forms of crime and new tools for detection.

Cong et al. (2023a) provide a taxonomy of crypto-related crime, including scams, Ponzi schemes, ransomware, and darknet transactions. They emphasize that DeFi's permissionless design — where anyone can launch a protocol without approval — facilitates both innovation and fraud, including "rug pulls", in which project founders withdraw user funds. Forensics play a central role in detecting such schemes. Extending this work, Cong et al. (2025) analyze ransomware using a dataset that combines on-chain transactions with leaked negotiation transcripts and dark web communications. They show that ransomware gangs operate much like firms, with reputation management and structured revenue models. Their results suggest that blanket restrictions on cryptocurrency may be ineffective, while targeted forensic interventions can disrupt organized groups.

Terrorism-related finance provides another application. Amiram et al. (2022) map Bitcoin transactions to service providers, exchanges, and mixers, and link them to terrorism event data. They find abnormal spikes in unregulated exchange and mixer activity before large, visible attacks. A case study of the 2019 Sri Lanka Easter bombings shows how forensic accounting can trace illicit transfers, and predictive models trained on these patterns forecast terror incidents with measurable accuracy. This evidence illustrates that even as cryptocurrencies provide tools for covert transfers, blockchain transparency enables systematic monitoring of illicit finance.

The literature therefore portrays a dual dynamic: the same features that enable open participation and innovation in DeFi — pseudonymity, permissionless entry, and composability — also facilitate crime, fraud, and systemic vulnerabilities. Yet these features simultaneously create new opportunities for forensic monitoring and regulatory intervention, making transparency a central determinant of resilience in decentralized financial markets.

5.3. Exchange manipulation and market integrity

Wash trading — the practice of traders buying and selling the same asset to inflate reported volume — has long been a concern in cryptocurrency markets. Cong et al. (2023b) develop a systematic methodology to detect manipulation on centralized exchanges. Using statistical benchmarks such as distributional regularities in trade sizes, they show that unregulated exchanges report highly inflated volumes, with over 70% of activity estimated to be fictitious, while regulated platforms largely conform to natural patterns.

Building on this, Amiram et al. (2025) analyze how competition shapes incentives to manipulate volume. Exploiting shocks such as the 2017 Chinese exchange ban and CoinMarketCap's 2019 ranking reform, they find that stronger competition increases the likelihood of inflated reporting. While fake volumes generate short-term visibility and traffic, they erode reputation over time, leading to reduced engagement and market share. This dynamic illustrates a trade-off between immediate rents and longer-term credibility.

Direct evidence comes from Aloosh and Li (2024), who study internal records from Mt. Gox. Among roughly 8 million trades, they identify more than 115,000 instances of wash trading, confirming suspicions of fabricated liquidity. These trades were smaller in size, concentrated among frequent participants, and increased apparent liquidity without improving execution. The authors also show that some indirect detection methods are reliable, while others are not. Extending the analysis to decentralized venues, Bazrafshan and Lehar (2025) document wash trading in blockchain-based decentralized exchanges, a surprising finding given that blockchain transparency makes detection easier.

The evidence indicates that both centralized and decentralized venues remain vulnerable to manipulation, and that transparency alone does not guarantee market integrity. Exchange design and regulatory oversight are critical for deterring practices that undermine trust in crypto and DeFi markets.

6. Regulatory frictions, taxation, and policy design

The rapid growth of decentralized finance has raised fundamental questions about how traditional regulatory frameworks apply to blockchain-based systems. Because DeFi protocols operate across borders, with pseudonymous participants and automated enforcement through smart contracts, conventional tools for taxation, investor protection, and financial stability are difficult to implement. Recent research examines how these frictions shape market outcomes, focusing on compliance with Know-Your-Customer (KYC) and Anti-Money-Laundering (AML) rules, the effectiveness of taxation in pseudonymous environments, and the design of policies that balance innovation with systemic risk mitigation. This section reviews empirical evidence on these challenges and how regulation influences the evolution of digital financial markets.

6.1. Regulatory arbitrage and market segmentation

Choi et al. (2020) analyze the persistent Bitcoin price premium in South Korea, known as the "Kimchi premium". Between 2016 and 2018, Bitcoin traded in Korea at an average premium of 5 percent over U.S. prices, at times exceeding 50 percent. The study attributes this to the interaction of capital controls with blockchain microstructure. Confirmation delays, volatile fees, and high price fluctuations raised arbitrage costs, while restrictions on cross-border currency transfers limited traders' ability to exploit the premium. Makarov and Schoar (2020) document a broader pattern of mispricing across many exchanges.

Extending this analysis, Borri and Shakhnov (2023) examine Bitcoin prices across 135 exchanges worldwide. They find persistent deviations, or "discounts", with substantial cross-sectional dispersion. Discrepancies are more pronounced in fiat-crypto pairs, where conversion requires access to banking channels, than in crypto-crypto pairs, where settlement is native to the blockchain. Price gaps are larger in countries with strict capital controls and correlate with local demand shocks, such as increased search activity, or with supply shocks, such as higher domestic mining. These findings underscore how regulatory frictions and market segmentation shape pricing even in globally traded assets.

Borri and Shakhnov (2020) study the international spillovers of regulatory bans, focusing on China's 2017 prohibition of cryptocurrency trading. The ban reduced RMB-denominated Bitcoin trading volume from over 90 percent of global activity to near zero within months. At the same time, trading surged in Korean won, Japanese yen, and U.S. dollars, while Chinese investors turned to peer-to-peer platforms such as LocalBitcoins. The shift produced localized price increases, consistent with segmentation and demand substitution across jurisdictions.

This evidence shows that capital controls, regulatory bans, and frictions in cross-border settlement sustain persistent price gaps across jurisdictions. For DeFi, which depends on seamless flows of collateral, stablecoins, and governance tokens, such segmentation introduces inefficiencies and complicates integration with traditional finance.

7. Conclusion

Decentralized finance has developed into a distinct financial architecture that replicates many functions of traditional finance while introducing new mechanisms, risks, and institutional forms. The empirical literature reviewed in this survey shows how protocol design and incentive structures shape outcomes across tokens, decentralized exchanges, lending platforms, derivatives, non-fungible tokens, and governance. Smart contracts, algorithmic execution, and composability create transparency, automation, and innovation, yet they also generate frictions such as maximal extractable value, liquidation spirals, phantom liquidity, and vulnerabilities in oracle and bridge design.

Evidence highlights that liquidity provision and price discovery in DeFi often depend on arbitrageurs and validators, creating distributional tensions with liquidity providers and retail users. Stablecoins, central to DeFi's systemic stability, vary widely in resilience depending on collateralization and governance but remain exposed to shocks from both crypto markets and traditional finance. Lending platforms increase leverage and market participation but amplify fragility through feedback loops, borrower inattention, and forced liquidations. NFTs illustrate the intersection of financial innovation with behavioral dynamics, adding new collateral and liquidity instruments but also amplifying speculative cycles.

Governance and infrastructure present persistent challenges. Governance tokens combine financial and control rights but often concentrate decision-making power. Airdrops, audits, oracle networks, and transparency tools improve adoption and monitoring but cannot fully substitute for credible oversight. Settlement dynamics and validator incentives show that decentralization is not absolute but contingent on design trade-offs, with maximal extractable value and private relays redistributing rents and reshaping trust.

At a systemic level, DeFi's integration with traditional finance magnifies both risks and opportunities. On-chain transparency enables novel approaches to monitoring and forensic analysis, but pseudonymity facilitates crime and regulatory evasion. Cross-market linkages, validator concentration, and stablecoin dependence raise concerns about resilience under stress. Environmental and sustainability issues, particularly in proof-of-work systems, further complicate long-term viability.

The survey highlights that DeFi is neither a replacement for traditional finance nor a passing fad, but an evolving financial system where innovation, efficiency, and access coexist with fragility, concentration, and systemic risk. Open questions remain for research and policy: whether decentralization is sustainable at scale, how governance can remain incentive-compatible, to what extent DeFi instruments will achieve long-run adoption, and how environmental and regulatory trade-offs will be managed. For policymakers, the central challenge is to design frameworks that preserve investor protection and systemic stability without stifling innovation, recognizing that many DeFi mechanisms substitute for conventional oversight.

DeFi thus functions as both a laboratory and a stress test for the future of finance. Its trajectory will depend on how protocol design, user behavior, and regulation interact, and on whether decentralized systems can reconcile openness and efficiency with resilience and sustainability.

CRediT authorship contribution statement

Jaime Castillo León: Conceptualization, Investigation, Validation, Writing – original draft, Writing – review & editing. **Alfred Lehar:** Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

No data was used for the research described in the article.

References

Adams, Austin, Lader, Mary-Catherine, Liao, Gordon, Puth, David, Wan, Xin, 2023. On-chain foreign exchange and cross-border payments. http://dx.doi.org/10.2139/ssrn.4328948, Working Paper.

Adams, Austin, Liao, Gordon, 2022. When uniswap v3 returns more fees for passive LPs. http://dx.doi.org/10.2139/ssrn.4671238, Working Paper.

Ahsan, Zaid Bin, Gupta, Agam, 2023. Gamified cryptocurrency and rewards: Consumer behaviour during uncertain earnings. J. Consum. Behav..

Allen, Darcy W.E., 2024. Crypto airdrops: An evolutionary approach. J. Evol. Econ. 1–24.

Allen, Darcy W.E., Berg, Chris, Lane, Aaron M., 2023. Why airdrop cryptocurrency tokens? J. Bus. Res. 163, 113945.

Aloosh, Arash, Li, Jiasun, 2024. Direct evidence of bitcoin wash trading. Manag. Sci. 70 (12), 8875–8921.
Amiram, Dan, Jørgensen, Bjørn N., Rabetti, Daniel, 2022. Coins for bombs: The predictive ability of on-chain transfers for terrorist attacks. J. Account. Res. 60 (2), 427–466.
Amiram, Dan, Lyandres, Evgeny, Rabetti, Daniel, 2025. Trading volume manipulation and competition among centralized crypto exchanges. Manag. Sci. 71 (10), 8604–8622.
Amsden, Ryan, Schweizer, Denis, 2018. Are blockchain crowdsales the new 'gold rush'? Success determinants of initial coin offerings. http://dx.doi.org/10.2139/ssrn.3163849, Working Paper.
Andolfatto, Andrea, Naik, Siddharth, Schönleber, Lorenzo, 2024. Decentralized and centralized options trading: A risk premia perspective. http://dx.doi.org/10.2139/ssrn.4822783, Working Paper.
Aquilina, Matteo, Foley, Sean, Gambacorta, Leonardo, Krekel, William, 2024. Decentralised dealers? Examining liquidity provision in decentralised exchanges. Working paper, BIS Working Papers No. 1227 Bank for International Settlements.
Aspris, Angelo, Foley, Sean, Svec, Jiri, Wang, Leqi, 2021. Decentralized exchanges: The "wild west" of cryptocurrency trading. Int. Rev. Financ. Anal. 77, 101845.
Augustin, Patrick, Chen-Zhang, Roy, Shin, Donghwa, 2022. Reaching for yield in decentralized financial markets. Working Paper.
Barbon, Andrea, Ranaldo, Angelo, 2023. NFT bubbles. http://dx.doi.org/10.48550/arXiv.2303.06051, Working Paper.
Barth, Andreas, Laturnus, Valerie, Mansouri, Sasan, Wagner, Alexander F., 2023. Conflicted analysts and initial coin offerings. Manag. Sci. 69 (11), 6641–6666.
Basu, Soumya, Easley, David, O'Hara, Maureen, Sirer, Emin Gün, 2023. StableFees: A predictable fee market for cryptocurrencies. Manag. Sci. 69 (11), 6508–6524.
Bazrafshan, Behnoud Alizadeh, Lehar, Alfred, 2025. Wash trading on decentralized exchanges. Working Paper.
Benedetti, Hugo, Kostovetsky, Leonard, 2021. Digital tulips? Returns to investors in initial coin offerings. J. Corp. Financ. 66, 101786.
Benetton, Matteo, Compiani, Giovanni, 2024. Investors' beliefs and cryptocurrency prices. Rev. Asset Pricing Stud. 14 (2), 197–236.
Bikunle, Gbenga, Mollica, Vito, Sun, Qiao, 2025. Why so many coins? Examining the demand for privacy-preserving cryptocurrencies. Br. Account. Rev. 101637.
Borri, Nicola, Liu, Yukun, Tsyvinski, Aleh, 2022. The economics of non-fungible tokens. http://dx.doi.org/10.2139/ssrn.4052045, Working Paper.
Borri, Nicola, Shakhnov, Kirill, 2020. Regulation spillovers across cryptocurrency markets. Financ. Res. Lett. 36, 101333.
Borri, Nicola, Shakhnov, Kirill, 2023. Cryptomarket discounts. J. Int. Money Financ. 139, 102963.
Bourveau, Thomas, De George, Emmanuel T., Ellahie, Atif, Macciocchi, Daniele, 2022. The role of disclosure and information intermediaries in an unregulated capital market: Evidence from initial coin offerings. J. Account. Res. 60 (1), 129–167.
Brolley, Michael, Zoican, Marius, 2023. On-demand fast trading on decentralized exchanges. Financ. Res. Lett. 103350.
Brownworth, Anders, Durfee, Jon, Lee, Michael, Martin, Antoine, 2024. Regulating decentralized systems: Evidence from sanctions on tornado cash. Working paper, Swiss National Bank Working Paper, Swiss National Bank.
Campello, Murillo, Jin, Peiyi, Rabetti, Daniel, Saleh, Fahad, 2023. The market for crypto zombies: Under-collateralization in defi lending.
Caparrós, Basile, Chaudhary, Amit, Klein, Olga, 2023. Blockchain scaling and liquidity concentration on decentralized exchanges. http://dx.doi.org/10.48550/arXiv.2306.17742, Working Paper.
Capponi, Agostino, Jia, Ruizhe, 2021a. The adoption of blockchain-based decentralized exchanges. http://dx.doi.org/10.48550/arXiv.2103.08842, Working Paper.
Capponi, Agostino, Jia, Ruizhe, 2025. Liquidity provision on blockchain-based decentralized exchanges. Rev. Financ. Stud. 38 (10), 3040–3085.
Capponi, Agostino, Jia, Ruizhe, Wang, Ye, 2025. Maximal extractable value and allocative inefficiencies in public blockchains. J. Financ. Econ. 172, 104132.
Capponi, Agostino, Jia, Ruizhe, Yu, Shihao, 2024b. Price discovery on decentralized exchanges. http://dx.doi.org/10.2139/ssrn.4236993, Working Paper.
Castillo, Jaime, Lehar, Alfred, 2024. When the bridge breaks: Market-implied default risk. Working Paper.
Chaudhary, Amit, Kozhan, Roman, Viswanath-Natraj, Ganesh, 2023a. Interest rate parity in decentralized finance. Working Paper.
Chaudhary, Amit, Kozhan, Roman, Viswanath-Natraj, Ganesh, 2023b. Interest rate rules in decentralized finance: Evidence from compound. In: Proceedings of the 4th International Conference on Blockchain Economics, Security and Protocols (Tokenomics 2022). Schloss Dagstuhl–Leibniz-Zentrum für Informatik, pp. 5:1–5:21.
Chemaya, Nir, Cong, Lin William, Jorgensen, Emma, Liu, Dingyue, Zhang, Luyao, 2023. Uniswap daily transaction indices by network. http://dx.doi.org/10.48550/arXiv.2312.02660, Working Paper.
Chen, Kun, Fan, Yifan, Liao, Shaoyi Stephen, 2023. Token incentives in a volatile crypto market: The effects of token price volatility on user contribution. J. Manage. Inf. Syst. 40 (2), 683–711.
Choi, Kyoung Jin, Lehar, Alfred, Stauffer, Ryan, 2020. Bitcoin microstructure and the Kimchi premium. Working Paper.
Cole, Benjamin M., Dyhrberg, Anne H., Foley, Sean, Svec, Jiri, 2022. Can bitcoin be trusted? Quantifying the economic value of blockchain transactions. J. Int. Financ. Mark. Institutions Money 79, 101577.
Cong, Lin William, Grauer, Kimberly, Rabetti, Daniel, Updegrave, Henry, 2023a. Blockchain forensics and crypto-related cybercrimes. http://dx.doi.org/10.2139/ssrn.4358561, Working Paper.
Cong, Lin William, Harvey, Campbell R., Rabetti, Daniel, Wu, Zong-Yu, 2025. An anatomy of crypto-enabled cybercrimes. Manag. Sci. 71 (4), 1987–2012.
Cong, Lin William, He, Zhiheng, Tang, Ke, 2022a. The tokenomics of staking. http://dx.doi.org/10.2139/ssrn.4059460, Working Paper.
Cong, Lin William, Karolyi, George Andrew, Tang, Ke, Zhao, Weiyi, 2022b. Value premium, network adoption, and factor pricing of crypto assets. http://dx.doi.org/10.2139/ssrn.3985631, Working Paper.
Cong, Lin William, Li, Xi, Tang, Ke, Yang, Yang, 2023b. Crypto wash trading. Manag. Sci. 69 (11), 6427–6454.
Cong, Lin William, Prasad, Eswar S., Rabetti, Daniel, 2023c. Financial and informational integration through oracle networks. http://dx.doi.org/10.2139/ssrn.4495514, Working Paper.
Cong, Lin William, Xiao, Yizhou, 2021. Categories and functions of crypto-tokens. In: The Palgrave Handbook of FinTech and Blockchain. pp. 267–284.
Cornelli, Giulio, Gambacorta, Leonardo, Garratt, Rodney, Reghezza, Alessio, 2024. Why DeFi lending? Evidence from aave V2. Working paper, BIS Working Papers No. 1183 Bank for International Settlements.
Dai, Min, Kou, Steven, Qian, Shuaijie, Qin, Ling, 2024. Bitcoin mining and climate damage. http://dx.doi.org/10.2139/ssrn.3994797, Working Paper.
Davydiuk, Tetiana, Gupta, Deeksha, Rosen, Samuel, 2023. De-crypto-ing signals in initial coin offerings: Evidence of rational token retention. Manag. Sci. 69 (11), 6584–6624.
Easley, David, O'Hara, Maureen, Basu, Soumya, 2019. From mining to markets: The evolution of bitcoin transaction fees. J. Financ. Econ. 134 (1), 91–109.
Easley, David, O'Hara, Maureen, Yang, Songshan, Zhang, Zhibai, 2024. Microstructure and market dynamics in crypto markets. http://dx.doi.org/10.2139/ssrn.4814346, Working Paper.
Eichengreen, Barry, Nguyen, My, Viswanath-Natraj, Ganesh, 2023. Stablecoin devaluation risk. Working Paper.
Fisch, Christian, Masiak, Christian, Vismara, Silvio, Block, Jörn, 2021. Motives and profiles of ICO investors. J. Bus. Res. 125 (3), 564–576.
Foley, Sean, Karlsen, Jonathan R., Putniņš, Tālis J., 2019. Sex, drugs, and bitcoin: How much illegal activity is financed through cryptocurrencies? Rev. Financ. Stud. 32 (5), 1798–1853.
Fritsch, Robin, Canidio, Andrea, 2024. Measuring arbitrage losses and profitability of AMM liquidity. In: Companion Proceedings of the ACM Web Conference 2024. pp. 1761–1767.
Galati, Luca, Capalbo, Francesco, 2024. Silicon valley bank bankruptcy and stablecoins stability. Int. Rev. Financ. Anal. 91, 103001.
Gandal, Neil, Halaburda, Hanna, 2016. Can we predict the winner in a market with network effects? Competition in the cryptocurrency market. Games 7 (3), 16.
Garratt, Rodney J., van Oordt, Maarten R.C., 2023. Why fixed costs matter for proof-of-work–based cryptocurrencies. Manag. Sci. 69 (11), 6482–6507.

Goldberg, Mitchell, Kugler, Peter, Schär, Fabian, 2024. Land valuation in the metaverse: Location matters. J. Econ. Geogr. 24 (5), 729–758.
Goldberg, Mitchell, Schär, Fabian, 2023. Metaverse governance: An empirical analysis of voting within decentralized autonomous organizations. J. Bus. Res. 160, 113764.
Heimbach, Lioba, Huang, Wenqian, 2023. Defi leverage. http://dx.doi.org/10.2139/ssrn.4459384, Working Paper.
Howell, Sabrina T., Niessner, Marina, Yermack, David, Wei, Jiang, 2020. Initial coin offerings: Financing growth with cryptocurrency token sales. Rev. Financ. Stud. 33 (9), 3925–3974.
Huang, Dong, Goetzmann, William N., 2023. Selection-neglect in the NFT bubble. http://dx.doi.org/10.3386/w31498, Working paper, NBER Working Paper No. 31498 National Bureau of Economic Research.
Huberman, Gur, Leshno, Jacob D., Moallemi, Ciamac C., 2021. Monopoly without a monopolist: An economic analysis of the bitcoin payment system. Rev. Econ. Stud. 88 (6), 3011–3040.
Johnson, William C., Scharnowski, Stefan, 2025. Wrapped tokens and price discovery. http://dx.doi.org/10.2139/ssrn.5300493, Working Paper.
Kanellopoulos, I.F., Gutt, Dominik, Li, Ting, 2021. Do non-fungible tokens (NFTs) affect prices of physical products? evidence from trading card collectibles. http://dx.doi.org/10.2139/ssrn.3918256, Working Paper.
Kanellopoulos, Ioannis Filippos, Gutt, Dominik, Tunc, Murat M., Li, Ting, 2023. How do platform subsidies affect creation, engagement, and pricing? evidence from non-fungible tokens. http://dx.doi.org/10.2139/ssrn.4335127, Working Paper / SSRN.
Kawai, Daisuke, Soska, Kyle, Routledge, Bryan, Zetlin-Jones, Ariel, Christin, Nicolas, 2025. Anatomy of a digital bubble: Lessons learned from the NFT and metaverse frenzy. http://dx.doi.org/10.48550/arXiv.2501.09601, Working Paper.
Klein, Olga, Kozhan, Roman, Viswanath-Natraj, Ganesh, Wang, Junxuan, 2023. Price discovery in cryptocurrencies: Trades versus liquidity provision. http://dx.doi.org/10.2139/ssrn.4642411, Working Paper.
Kogan, Shimon, Makarov, Igor, Niessner, Marina, Schoar, Antoinette, 2024. Are cryptos different? Evidence from retail trading. J. Financ. Econ. 159, 103897.
Kozhan, Roman, Viswanath-Natraj, Ganesh, 2021. Decentralized stablecoins and collateral risk. Working Paper.
Kozhan, Roman, Viswanath-Natraj, Ganesh, 2022. Fundamentals of the makerdao governance token. In: Proceedings of the 3rd International Conference on Blockchain Economics, Security and Protocols (Tokenomics 2021). Schloss Dagstuhl–Leibniz-Zentrum für Informatik, pp. 11:1–11:21.
Lambert, Thomas, Liebau, Daniel, Roosenboom, Peter, 2022. Security token offerings. Small Bus. Econ. 59 (1), 299–325.
Landsman, Wayne R., Lyandres, Evgeny, Maydew, Edward L., Rabetti, Daniel, 2025. Auditing smart contracts. http://dx.doi.org/10.2139/ssrn.5198563, Working Paper.
Laturnus, Valerie, 2023. The economics of decentralized autonomous organizations. http://dx.doi.org/10.2139/ssrn.4320196, Working Paper.
Lee, Jongsub, Li, Tao, Shin, Donghwa, 2022. The wisdom of crowds in fintech: Evidence from initial coin offerings. Rev. Corp. Financ. Stud. 11 (1), 1–46.
Lehar, Alfred, Moravvej, Moty, 2024. Private settlement in blockchain systems. http://dx.doi.org/10.2139/ssrn.4799496, Working Paper.
Lehar, Alfred, Parlour, Christine A., 2020. Miner collusion and the bitcoin protocol. http://dx.doi.org/10.2139/ssrn.3559894, Working Paper.
Lehar, Alfred, Parlour, Christine A., 2023. Battle of the bots: Flash loans, miner extractable value and efficient settlement. Working Paper.
Lehar, Alfred, Parlour, Christine A., 2025. Decentralized exchange: The uniswap automated market maker. J. Financ. 80 (1), 321–374.
Lehar, Alfred, Parlour, Christine A., Zoican, Marius, 2022. Systemic fragility in decentralized markets. http://dx.doi.org/10.2139/ssrn.4164833, Working Paper.
Lehar, Alfred, Parlour, Christine A., Zoican, Marius, 2024. Fragmentation and optimal liquidity supply on decentralized exchanges. http://dx.doi.org/10.2139/ssrn.4267429, Working Paper.
Li, Jiasun, Mann, William, 2021. Initial coin offerings: Current research and future directions. In: The Palgrave Handbook of Technological Finance. Springer, pp. 369–393.
Li, T.N., Naik, S., Papanicolaou, A., Schoenleber, L., 2025. Implied impermanent loss: A cross-sectional analysis of decentralized liquidity pools. Working Paper.
Li, Jiasun, Yi, Guanxi, 2018. Toward a factor structure in crypto asset returns. http://dx.doi.org/10.2139/ssrn.3258231, Working Paper.
Liang, Chen, Tunc, Murat M., Burtch, Gordon, 2024. The market consequences of perceived strategic generosity: An empirical examination of NFT charity fundraisers. Working Paper.
Liao, Gordon, 2022. Macroprudential considerations for tokenized cash. http://dx.doi.org/10.2139/ssrn.4228268, Working paper, Finance and Economics Discussion Series 2022-083 Board of Governors of the Federal Reserve System.
Liu, Yulin, Lu, Yuxuan, Nayak, Kartik, Zhang, Fan, Zhang, Luyao, Zhao, Yinhong, 2022. Empirical analysis of EIP-1559: Transaction fees, waiting times, and consensus security. In: Proceedings of the 2022 ACM SIGSAC Conference on Computer and Communications Security. CCS, ACM, pp. 2099–2113.
Liu, Jiageng, Makarov, Igor, Schoar, Antoinette, 2023. Anatomy of a run: The terra luna crash. http://dx.doi.org/10.3386/w31524, Working paper, NBER Working Paper No. 31524 National Bureau of Economic Research.
Liu, Yukun, Tsyvinski, Aleh, 2021. Risks and returns of cryptocurrency. Rev. Financ. Stud. 34 (6), 2689–2727.
Liu, Yulin, Zhang, Luyao, 2023. Cryptocurrency valuation: An explainable AI approach. In: Science and Information Conference. Springer Nature Switzerland, Cham, pp. 785–807.
Lo, Yuen C., Medda, Francesca, 2020. Assets on the blockchain: An empirical study of tokenomics. Inf. Econ. Policy 53, 100881.
Lundy, Taylor, Raman, Narun Krishnamurthi, Kominers, Scott, Leyton-Brown, Kevin, 2024. NFTs as a data-rich test bed: Conspicuous consumption and its determinants. In: The Web Conference 2025.
Lyandres, Evgeny, Palazzo, Berardino, Rabetti, Daniel, 2022. Initial coin offering (ICO) success and post-ICO performance. Manag. Sci. 68 (12), 8658–8679.
Lyandres, Evgeny, Zaidelson, Alexander, 2024. Does market efficiency impact capital allocation efficiency? The case of decentralized exchanges. Working Paper.
Lyons, Richard K., Viswanath-Natraj, Ganesh, 2023. What keeps stablecoins stable? J. Int. Money Financ. 131, 102777.
Ma, Yiming, Zeng, Yao, Zhang, Anthony Lee, 2023. Stablecoin runs and the centralization of arbitrage. http://dx.doi.org/10.2139/ssrn.4398546, Working Paper.
Makarov, Igor, Schoar, Antoinette, 2020. Trading and arbitrage in cryptocurrency markets. J. Financ. Econ. 135 (2), 293–319.
Makarov, Igor, Schoar, Antoinette, 2021. Blockchain analysis of the bitcoin market. http://dx.doi.org/10.2139/ssrn.3942181, Working Paper.
Makarov, Igor, Schoar, Antoinette, 2022. Cryptocurrencies and decentralized finance (DeFi). Brookings Pap. Econ. Act. 2022 (1), 141–215.
Messias, Johnnatan, Yaish, Aviv, Livshits, Benjamin, 2023. Airdrops: Giving money away is harder than it seems. http://dx.doi.org/10.48550/arXiv.2312.02752, Working Paper.
Milionis, Jason, Moallemi, Ciamac C., Roughgarden, Tim, Zhang, Anthony Lee, 2022. Automated market making and loss-versus-rebalancing. http://dx.doi.org/10.48550/arXiv.2208.06046, Working Paper.
Moallemi, Ciamac C., Patange, Utkarsh, 2024. An analysis of fixed-spread liquidation lending in defi. In: International Conference on Financial Cryptography and Data Security. Springer, pp. 105–127.
Momtaz, Paul P., 2020. Initial coin offerings. PLoS One 15 (5), e0233018.
Mueller, Peter, 2024. DeFi leveraged trading: Inequitable costs of decentralization. http://dx.doi.org/10.2139/ssrn.4241356, Working Paper.
Myalo, Alina, Glukhov, Nikita, 2019. Comparison analysis of ICO, DAOICO, IEO and STO: Case study. Working Paper.
Nadler, Matthias, Schär, Fabian, 2023. Tornado cash and blockchain privacy: A primer for economists and policymakers. Fed. Reserv. Bank St. Louis Rev. 105 (2), 122–136.
Oefele, Nico, Baur, Dirk G., Smales, Lee A., 2024. Flight-to-quality — money market mutual funds and stablecoins during the march 2023 banking crisis. Econom. Lett. 234, 111464.
Oh, Sebeom, 2024. Market manipulation in non-fungible token markets. http://dx.doi.org/10.2139/ssrn.4397409, Working Paper.
Oh, Sebeom, Rosen, Samuel, Zhang, Anthony Lee, 2023. Digital veblen goods. http://dx.doi.org/10.2139/ssrn.4042901, Working Paper.

Oliveira, Luis, Zavolokina, Liudmila, Bauer, Ingrid, Schwabe, Gerhard, 2018. To token or not to token: Tools for understanding blockchain tokens. In: ICIS (Proceedings of the International Conference on Information Systems).

Park, Andreas, Stinner, Jona, 2023. Phantom liquidity in decentralized lending. http://dx.doi.org/10.2139/ssrn.4428173, Working Paper.

Petryk, Mariia, Li, Jiasun, 2024. Governance diversity in blockchain open-source development community. http://dx.doi.org/10.2139/ssrn.5024712, Working Paper.

Prat, Julien, Walter, Benjamin, 2021. An equilibrium model of the market for bitcoin mining. J. Political Econ. 129 (8), 2415–2452.

Rabetti, Daniel, 2023. Auditing decentralized finance (DeFi) protocols. Working Paper.

Shams, Amin, 2022. Cryptocurrency exchanges and comovements of cryptocurrency returns. p. 011, Working Paper — Fisher College of Business 2020–03.

Soska, Kyle, Dong, Jin-Dong, Khodaverdian, Alex, Zetlin-Jones, Ariel, Routledge, Bryan, Christin, Nicolas, 2021. Towards understanding cryptocurrency derivatives: A case study of BitMEX. In: Proceedings of the Web Conference 2021. pp. 45–57.

Spain, Michael, Foley, Sean, Gramoli, Vincent, 2020. The impact of ethereum throughput and fees on transaction latency during ICOs. In: Proceedings of the International Conference on Blockchain Economics, Security and Protocols. Tokenomics 2019, Schloss Dagstuhl–Leibniz-Zentrum für Informatik, pp. 9:1–9:18.

Tovanich, Natkamon, Marcassa, Stefania, Kitzler, Stefan, Makridis, Christos, Prat, Julien, 2025. Shock propagation in decentralized lending networks: Evidence from the compound protocol. http://dx.doi.org/10.2139/ssrn.5380164, Working Paper.

Tunc, Murat M., Cavusoglu, Hasan, Zheng, Eric, 2024. Resale royalty in NFT marketplaces: Blessing or burden for creators and platforms. Inf. Syst. Res. 35 (1), 82–110.

Uhlig, Harald, 2022. A luna-tic stablecoin crash. http://dx.doi.org/10.3386/w30256, Working paper, NBER Working Paper No. 30256 National Bureau of Economic Research.

Zhang, Yufan, Chen, Zichao, Sun, Yutong, Liu, Yulin, Zhang, Luyao, 2023. Blockchain network analysis: A comparative study of decentralized banks. In: Science and Information Conference. Springer Nature Switzerland, Cham, pp. 1022–1042.

Zhu, Brian Z., Liu, Dingyue, Wan, Xin, Liao, Gordon, Moallemi, Ciamac C., Bachu, Brad, 2024. What drives liquidity on decentralized exchanges? Evidence from the uniswap protocol. http://dx.doi.org/10.48550/arXiv.2410.19107, Working Paper.