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The Application of Blockchain Technology in Quantitative Finance: Design of Decentralized Trading Systems

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Abstract. With the rapid advancement of blockchain technology and the expanding influence of decentralized finance (DeFi), centralized trading systems (CEX) increasingly confront critical challenges including single points of failure, insufficient data transparency, and elevated transaction costs. Therefore, it is imperative to develop and explore decentralized trading systems that are compatible with and adaptive to quantitative trading strategies. This study focuses on constructing a framework for decentralized trading systems suitable for quantitative strategies, aiming to reduce transaction costs, enhance strategy transparency, and improve risk resistance capabilities. By analyzing the technical architecture (including public chain adaptations: Solana for high-frequency strategies and Ethereum Layer 2 for medium-frequency strategies), innovations in decentralized exchanges (DEX) (such as order-book based dYdX and AMM based Uniswap V3), and the application of on-chain quantitative tools (like Nansen for whale behavior tracking and automated execution tools based on Aave smart contracts), the study confirms the feasibility and advantages of decentralized design in quantitative scenarios.

Keywords: Decentralized Exchange (DEX), Quantitative Strategy, Smart Contract

1. Introduction

1.1. Research background

Since the birth of blockchain technology, it has rapidly found widespread applications in various fields due to its decentralized, immutable, and highly transparent distributed ledger characteristics. In 2008, Nakamoto introduced the concept and technical framework of decentralized and trustless digital currency and payment mechanisms in the paper “Bitcoin: A Peer-to-Peer Electronic Cash System,” marking the beginning of a new era for blockchain technology [1]. The subsequent emergence of the Ethereum platform further propelled the development of blockchain technology, with its smart contract functionality becoming the core vehicle for decentralized applications (DApps), leading to the rise of decentralized finance (DeFi). The application of blockchain technology in the financial industry, from payment settlement to securities trading, and from risk management to financial regulation, has demonstrated immense potential.

However, in contrast to the rapid development of blockchain technology, traditional centralized exchange systems (CEX) still face numerous challenges. First, there is a significant single point of

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risk; failures of key servers or large financial institutions can disrupt the entire trading ecosystem. Second, the issues of data opacity and manipulation risks cannot be overlooked. The centralized management of data in exchanges can easily lead to information manipulation and a lack of transparency, as the sources of trading data are limited and may be altered or falsified, affecting the accuracy of traders' decisions. Lastly, the burden of high transaction fees is an urgent problem that needs to be addressed. In blockchain systems, limited computational and storage resources must be allocated through transaction fee mechanisms (TFMs), and during peak times, transaction fees on Ethereum can exceed $50, severely impacting user experience.

1.2. Research direction and objectives

Initially, centralized exchanges were the main venues for digital currency trading, occupying the vast majority of the market share, such as trading platforms like Binance and CoinBase; once a failure occurs, it can disrupt the entire trading ecosystem [2]. There are many historical events that have led to significant asset losses for exchanges, such as the Mt. Gox incident in 2014, the Bitfinex incident in 2016, and the QuadrigaCX incident in 2019. This also confirms the necessary role of decentralized exchanges (DEXs) in eliminating the risk of single points of failure.

Centralized management of data in exchanges can indeed lead to issues of false manipulation and lack of transparency. This is because the sources of trading data are often limited and may be subject to tampering or forgery, such as through manipulation of fake trading volumes. Such situations can result in traders formulating strategies based solely on unreliable information, thereby affecting the accuracy of their decisions. To improve this situation, it is advisable to introduce more data sources and transparency mechanisms to ensure the authenticity and reliability of trading data [3].

The limited computational and storage resources in blockchain systems need to be allocated through transaction fee mechanisms (TFMs). For example, transaction fees on Ethereum exceeded $50 during peak periods, significantly affecting user experience. This phenomenon is referred to as the "transaction fee crisis," indicating a pressing need to optimize transaction fee mechanisms to lower costs [4]. To achieve these research objectives, the study will focus on the following questions:

How to design an effective decentralized trading system architecture to eliminate single point failure risks and enhance the system's risk resistance?

How to optimize transaction fee mechanisms to lower fees while ensuring the stability and predictability of transaction costs?

How to achieve traceability and transparency of on-chain data to prevent data manipulation and opacity, thus improving the accuracy of trading decisions?

2. Technical architecture and strategy verification

2.1. Technical architecture (focusing on applications rather than technical details)

A base layer public blockchain is a decentralized network without an official organization or central server, where nodes can freely connect and participate in network operations according to system rules. Through a consensus mechanism, nodes achieve collaborative work. Any node has the right to participate in the consensus process (e.g., Solana, Ethereum), and its performance metrics (such as transaction latency and throughput) directly impact the operational efficiency of upper-layer applications.

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In the field of quantitative trading of digital assets, the performance of the base layer public blockchain is a core factor determining the applicability and effectiveness of quantitative strategies. Different public blockchains, due to design goal differences, exhibit significant differentiation in high-frequency and medium-frequency strategies, which has been fully validated in DeFi practices.

2.1.1. High-frequency strategies: Solana (TPS 65k, latency ≤ 400ms)

Solana, with its native high throughput design, has become the core platform for high-frequency arbitrage strategies. In actual operation, its peak transaction processing capability (TPS) can reach up to 65k, with stable transaction latency at ≤ 400ms [5]. For high-frequency arbitrage strategies, Solana's low latency feature becomes a core advantage in capturing instant price discrepancies across markets. Its unique PoH consensus mechanism pre-validates transaction orders through encrypted timestamp sequences, keeping transaction latency stable below 400ms.PoH enables network verifiers to ascertain past events with a degree of certainty regarding their timing. As the PoH generator emits a continuous stream of messages, all verifiers must submit their signatures of the state within 500 milliseconds, a timeframe that can be further shortened based on network conditions. Since each verification is integrated into the stream, every participant in the network can confirm that all verifiers cast their votes within the stipulated timeout, without needing to observe the voting process directly [6].

Moreover, Solana's low-cost characteristic further amplifies the profit margins of high-frequency arbitrage. Research by Multicoin Capital indicates that even with a daily processing volume of 50,000 TPS, users incur negligible transaction fees for each DeFi transaction, which aligns well with the "small amounts, multiple transactions" characteristic of high-frequency strategies. By reducing the cost loss per transaction, it significantly enhances the cumulative returns of multiple arbitrage operations. This "low latency + low cost" dual advantage makes Solana the core platform for high-frequency quantitative trading in a decentralized environment.

2.1.2. Medium-frequency strategies: Ethereum Layer 2 (zk-Rollup latency compressed to 50ms)

The Ethereum mainnet is limited by its throughput (approximately 15-30 TPS), making it challenging to support high-frequency trading, and the fluctuating gas fees, especially during network congestion, can significantly increase arbitrage costs, thereby restricting medium-frequency strategies. Layer 2, as an independent extension solution for Ethereum, achieves efficiency breakthroughs through a "off-chain computation + on-chain settlement" model, becoming the core platform for medium-frequency strategies (e.g., trend tracking with holding periods from 1 hour to 1 day).

The technical advantages of Layer 2 manifest in two aspects:

First, cost and throughput optimization. Compared to the mainnet (Layer 1), Layer 2 can reduce gas fees by up to 100 times, and transaction costs decrease with the increase in batch size. For instance, when a batch contains 50 transactions, gas costs can drop by over 85% [7]. Using zk-Rollup as an example, it compresses off-chain transaction data using zero-knowledge proofs (zk-SNARK), only validating key proofs on-chain, enhancing throughput to over 100 times that of the mainnet, with latency reduced to around 50ms [8]. This meets the needs for capturing non-instantaneous opportunities while avoiding the extreme low-latency dependence of high-frequency trading.

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Second, ecosystem compatibility. Ethereum Layer 2 is compatible with the rich DeFi protocols of the mainnet (e.g., Aave, Curve), allowing strategies to access multiple liquidity pools for cross-pool arbitrage through Layer 2, leveraging ecosystem synergies to expand the operational space of medium-frequency strategies. This "efficient low-cost + ecosystem compatibility" dual characteristic makes Layer 2 an ideal choice for balancing trading efficiency and strategy flexibility, effectively supporting the implementation of medium-frequency strategies in a decentralized environment.

2.2. Decentralized exchange (DEX) innovations

2.2.1. Order book DEX: low latency and leverage support

Order book decentralized exchanges (DEX) are typified by dYdX, whose core advantage stems from a hybrid architecture of "off-chain matching + on-chain settlement"—achieving high-frequency order matching through off-chain infrastructure while only submitting final results to the chain for settlement. This approach balances trading efficiency and security while retaining the core characteristic of decentralization [9].

As a high-transaction volume order book DEX, dYdX has implemented several practical features: firstly, its off-chain matching mechanism compresses transaction latency to around 50ms, significantly enhancing order execution speed and effectively avoiding slippage issues caused by blockchain network congestion; secondly, it enables zero gas fee transactions, reducing the cost losses of high-frequency trading. However, it is important to note that while off-chain matching does not involve gas fees, it may incur implicit slippage costs or be affected by insufficient liquidity. For instance, during periods of high market volatility, large orders may not be matched at the desired price due to the relatively limited capital in off-chain liquidity pools, leading to slippage and causing the actual transaction price to deviate from expectations. Additionally, if there are few liquidity providers for specific assets off-chain, there may also be liquidity shortages, affecting the smooth execution of trades and transaction costs. Thirdly, dYdX supports derivative markets such as perpetual contracts and offers 10x leverage [10]. For quantitative strategies, the leverage mechanism can significantly amplify arbitrage profits (e.g., a 1% cross-market price difference can translate into a 10% return under 10x leverage), while on-chain settlement is automatically completed through smart contracts, completely avoiding counterparty default risks associated with centralized platforms [10].

It is essential to note that dYdX's operational process requires users to deposit ETH into a designated smart contract before trading, and during the trading process, tokens cannot be accessed directly through wallets. While this design somewhat limits direct asset liquidity, it enhances trading security through the immutability of on-chain settlement [9]. This architecture allows dYdX to retain the advantages of decentralization while achieving trading efficiency comparable to centralized exchanges, making it an important platform for high-frequency arbitrage and leveraged trading strategies.

2.2.2. AMM DEX: breakthrough in capital efficiency

AMM DEXs, exemplified by Uniswap V3, have achieved a groundbreaking improvement in capital efficiency through the design of "concentrated liquidity pools"—increasing efficiency by 400% compared to version V2. Traditional AMMs (such as Uniswap V1/V2) distribute liquidity evenly across all price ranges, causing approximately 90% of funds to remain idle over long periods;

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whereas V3 allows liquidity providers to concentrate their funds within specific price ranges (e.g., ETH/USDC between $1800-$2000), reducing trading slippage within that range to below 0.1% [11]. This design is critically significant for quantitative market-making strategies: the same amount of capital can generate four times the fee income compared to V2, particularly during periods of ETH price volatility, where V3 market makers earn significantly more than traditional models.

The rise of the AMM model stems from underlying blockchain limitations: high gas fees make it challenging to implement traditional financial order book models on-chain, while AMM improves on-chain operational efficiency through predefined mathematical pricing rules (like Uniswap's x*y=k formula) [10]. However, this model has inherent flaws: liquidity providers face impermanent loss risks, and traders must endure price slippage, which remains a primary challenge of current AMM designs [10].

From the perspective of functional adaptability, AMMs and order book models each have their strengths: AMMs are more suitable for simplified on-chain trading scenarios, yet their complexity limits deployment in areas such as prediction markets; while order book models support more flexible features (such as leverage and limit orders), they are constrained by the performance limitations of blockchain architecture [10]. With the growth of DeFi demand, AMMs serve as a viable alternative to centralized order books, balancing capital efficiency and decentralization, thus becoming an important cornerstone of the decentralized finance ecosystem.

2.3. On-chain quantitative tools

2.3.1. Data analysis tools: whale behavior tracking

In the cryptocurrency market, "whales" refer to large investors holding significant amounts of cryptocurrency assets (typically representing a substantial proportion of total supply), whose trading activities can significantly influence market price fluctuations [12]. If ordinary investors are likened to "small fish" (wallet addresses holding mid to low-value cryptocurrencies), whales, with their substantial holdings (e.g., Ethereum whales holding about one-third of the total ETH supply), become key influencers of market trends.

The underlying logic of whale tracking is based on the transparency of blockchain: all transactions are recorded on a public ledger, and significant transfer records can be identified through blockchain explorers (like Etherscan) to locate whale addresses. For example, when a wallet address executes a single ETH transfer exceeding $100,000, it may indicate whale activity [12]. Additionally, social media platforms (like Twitter) serve as sources for tracking leads, as some whales may influence market sentiment through public statements, although caution is advised regarding their potential to manipulate prices using information.

Whale tracking in cryptocurrencies involves scanning the blockchain using API tools to monitor the trading activities of whale addresses (such as large buys or sells and cross-chain transfers) and analyze their market intentions. For instance, using Nansen's whale tracking API, it can accurately identify whale accounts with holdings over $100 million through an on-chain address labeling system, capturing building signals (like a single purchase of 100,000 ETH) and cross-chain capital flows (such as transferring USDC from an exchange wallet to a DEX) [13].

These tools provide quantitative strategies with "leading indicators"—research shows that whale holding changes have a significant correlation with the next day's ETH price: a 1% increase in holdings correlates with an average increase of 0.6263% in the next day's ETH return, while small retail investors' holdings correlate negatively with the next day's return [12]. Although the overall sample period covers from January 2018 to December 2023, special attention is given to the period

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termed “crypto winter” by Gordon and Zhang in 2022. For example, during the BTC bear market in 2022, tracking continuous net selling signals from whales allowed strategies to reduce positions 1-3 hours in advance, minimizing maximum drawdown by 20% [13].

Operational Steps and Practical Tips:

(1) Identify Target Whales:

Utilize blockchain explorers (like Etherscan) to filter for addresses holding significant amounts of cryptocurrency, or monitor news-exposed institutional or individual addresses (like those related to Sun Yuchen or SBF).

(2) Validate with Historical Data:

Whale addresses often exhibit patterns in trading, such as adjusting positions before market fluctuations [12].

(3) Apply Deep Analysis Tools:

In Nansen, use the “Wallet Profiler” feature to enter an address and view holding details, trading frequency, and associated protocols (like preferred DEXs or lending platforms).

(4) Set Up Real-Time Alerts:

Customize monitoring thresholds (e.g., transfers exceeding $1 million) and receive real-time notifications via email or app push to ensure timely capture of whale movements. While Nansen offers basic free features, its paid plans (like $99 per month) unlock more detailed whale activity data and market analysis tools, aiding investors in optimizing quantitative strategies based on whale behavior.

2.3.2. Automated execution tools: smart contract trigger mechanisms

Aave, as a decentralized non-custodial liquidity market protocol, has evolved into a core infrastructure in the DeFi lending space since its deployment on Ethereum in 2017 under the name ETHlend central to aave’s innovation is its departure from the conventional, direct lending relationships between individual lenders and borrowers, a model previously seen in platforms like ethlend. instead, aave introduces a more dynamic and fluid mechanism, where contributions form a communal liquidity pool from multiple lenders. This eliminates the need for direct matching between lenders and borrowers, with interest rates being dynamically adjusted by market supply and demand [14].

The core innovative mechanisms are reflected in three aspects:

(1) Decentralized Credit Model:

Aave builds liquidity pools through smart contracts, replacing traditional banking credit assessment processes. This relies solely on the value of collateral and oracle price data to automate the entire lending process [15].

(2) Dynamic Interest Rate Model:

Interest rates are adjusted in real-time based on the utilization rate (U), which refers to the proportion of funds borrowed from the pool. When U approaches a critical point, both deposit and borrowing rates increase exponentially, balancing liquidity supply and demand through economic incentives, thus avoiding the risk of a bank run [14].

(3) Flash Loan Feature:

Leveraging the atomicity of blockchain transactions, Aave supports uncollateralized instant loans that must be repaid within the same block, providing a low-cost funding tool for strategies like arbitrage and liquidation.

The conditional trigger-based transactions of Aave’s smart contracts are key tools for quantitative strategies. For instance, a dynamic hedging strategy can preset rules such that if the price of ETH

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drops by more than 5%, it will automatically execute the hedge operation of "borrow USDC → buy ETH."

The advantages of this mechanism include firstly, zero manual intervention. It means on-chain triggers have a delay of ≤100ms, far surpassing the response speed of manual operations; risk smoothing effects: data from 2023 indicates that quantitative portfolios using this tool exhibit an annualized volatility reduction of 15% compared to manual hedging. Secondly, ecosystem compatibility. It can integrate with oracles such as Chainlink to obtain real-time cross-chain price data, ensuring the accuracy of trigger conditions.

However, the security of smart contracts must be validated through multiple rounds of audits. Just as code generation tools (like GitHub Copilot) can introduce vulnerabilities, logical flaws in on-chain tools can lead to substantial losses—such as the flash loan attack incident in Aave V1 in 2021, which stemmed from vulnerabilities in the smart contract's exchange rate calculations [16]. Therefore, before deploying strategies, it is crucial to conduct formal verification (such as CertiK audits) and simulation testing to identify potential risks related to re-entrancy attacks, permission management, and more [17].

2.4. Comparative analysis of multi-strategy: DEX vs. centralized exchanges

In the cryptocurrency trading ecosystem, decentralized exchanges (DEX) and centralized exchanges (CEX) demonstrate significant divergence in strategy execution efficiency, risk characteristics, and applicable scenarios due to differences in their underlying architectures. This is particularly evident in core strategies such as cross-chain arbitrage and liquidity mining.

Cross-chain arbitrage profits from capturing price differences of assets between different blockchain networks, and its performance in CEX and DEX varies due to differences in trading mechanisms.

CEX, with its high liquidity and deep order books (e.g., Binance's deep ETH/USDT order flow), can quickly execute large arbitrage trades, reducing slippage risk. However, it is constrained by centralized regulations (such as withdrawal audits) and off-chain settlement delays, which may cause it to miss instantaneous price discrepancy windows [9].

DEX utilizes smart contracts to achieve "atomic swaps" (e.g., Uniswap's cross-chain pool design), which reduces the credit risk associated with transferring assets across chains [17]. However, the AMM model relies on liquidity pool pricing, and dispersed liquidity (e.g., independent pricing for USDC pools on Polygon and Ethereum) may lead to higher slippage, requiring arbitrageurs to dynamically adjust their strategies in response to on-chain price fluctuations [18].

As a core strategy in DeFi, liquidity mining operates differently in CEX and DEX. CEX offers similar services (e.g., Binance's staking wealth management) where the platform centrally manages assets. While the returns are stable, transparency is low. Earnings primarily come from transaction fee sharing, and users lack governance participation, exposing them to the moral hazard of platform asset misappropriation [19]. DEX liquidity mining (e.g., Saber's stablecoin pool) uses smart contracts to automatically distribute trading fees and governance tokens (such as SBR). This offers higher earning potential but comes with risks of "impermanent loss" (the reduction in pool asset value due to price volatility) and smart contract vulnerabilities [20]. Research indicates that optimizing AMM parameters (e.g., Curve's dynamic fee mechanism) can reduce impermanent loss and enhance LP returns [21].

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3. Strategy discussion and case analysis: Ethereum's practices and validation in institutional finance

Ethereum, with its flexible architecture and smart contract capabilities, has become the core platform for financial institutions exploring blockchain applications. Several benchmark cases validate its potential in meeting regulatory compliance, enhancing trading efficiency, and supporting complex financial instruments, forming a positive cycle of "practice - trust - further adoption."

3.1. From practice to trust: the compliance path and adoption cycle of Ethereum's enterprise applications

3.1.1. Jpmorgan's Quorum and JPM coin

Between 2016 and 2017, JPMorgan developed the Quorum alliance chain protocol, based on a fork of Ethereum, to support enterprise-level financial use cases. As a customized version of Ethereum, Quorum meets the needs of financial institutions through three core enhancements: QuorumChain(A new consensus mechanism based on majority voting that enhances transaction confirmation efficiency), constellation (a peer-to-peer encrypted information exchange function that ensures transaction privacy), and Peer Security (a smart contract-based node permission management that ensures controlled network access) [15].

In terms of data privacy and compliance, Quorum adopts an "off-chain storage" architecture: private transaction messages are relayed off-chain, with only encrypted fingerprints recorded on the blockchain, satisfying regulatory requirements for transaction traceability while protecting sensitive information [22]. This design allows Quorum to adapt to stringent financial regulatory frameworks, such as automating the execution of loan agreement terms via smart contracts, significantly enhancing transaction efficiency [15].

Launched in 2019, JPM Coin is a typical application of Quorum, used for interbank transfer scenarios. Practice has shown that its architecture (even in private deployment form) fully meets data protection and compliance requirements. A JPMorgan survey in 2021 indicated that 85% of clients believe blockchain-based services are more trustworthy and transparent than traditional financial services [15]. In compliance processes, Quorum's automation mechanisms have reduced regulatory audit time by 50%, significantly lowering compliance costs—previously requiring manual review of transaction records, which was time-consuming and expensive, while Quorum allows regulators real-time access to transaction data, optimizing processes.

3.1.2. Ethereum practices for regulated securities: from bond issuance to CBDC settlement

Both Ethereum's public mainnet and consortium chain deployments have been validated by financial institutions, particularly demonstrating advantages in securities issuance by "reducing intermediaries and enhancing transparency".

Through its SocGen FORGE platform, it successfully issued secured bonds worth €100 million on the Ethereum public mainnet. This case proves that regulated securities can be issued and settled on a public blockchain, maximizing the reduction of intermediary involvement and simplifying processes [23].

European Investment Bank (EIB) collaborated with Goldman Sachs, Santander Bank, and Societe Generale to issue €100 million digital bonds on Ethereum, innovatively using the central bank digital currency (CBDC) issued by the Banque de France for settlement. This practice highlights

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Ethereum's integration potential in a fully unified capital market involving "traditional financial instruments - CBDC - blockchain", providing a technical template for value transfer across institutions and instruments.

3.1.3. Insights from cases: trust reinforcement and adoption cycle of Ethereum

These cases collectively enhance Ethereum's credibility in the institutional domain. For financial institutions, trust is built on "validated use cases" and "reference cases from regulated participants": JPMorgan's compliance practices verify Ethereum's adaptability to privacy and regulation, while the cases of Societe Generale and EIB showcase its capacity to support complex financial instruments within a public chain environment. This "practice - validation - trust" cycle continues to attract more institutional participation, promoting the deep application of Ethereum in the financial sector.

3.2. Market environment adaptability analysis

3.2.1. Efficient markets—such as U.S. stocks

The temporal and spatial constraints of traditional securities markets have long restricted cross-border investment activities. The trading hours of the U.S. stock market are from 9:30 AM to 4:00 PM EST Monday through Friday, which corresponds to the late night in Asian time zones, creating a natural barrier to participation [24]. For ordinary Asian investors, factors such as time zone barriers, account opening thresholds, and cross-border capital flow regulations further limit their investment channels in popular stocks like Tesla, Nvidia, and Microsoft.

The emergence of tokenization technology has completely reshaped this landscape. For instance, the Jupiter decentralized exchange on the Solana blockchain has launched token products such as TSLAx and AAPLx, enabling 24/7 on-chain trading settled in USDC. These products operate based on an automated market maker (AMM) mechanism, breaking through traditional exchange time constraints and counterparty matching limitations, while also eliminating cumbersome identity verification processes.

The core value of U.S. stock tokenization extends far beyond simple trading channel expansion; it also constructs an interface for integrating real assets with DeFi ecosystems. In the blockchain environment, stock tokens not only serve as investment targets but also become programmable financial components capable of cross-protocol circulation and innovative applications through smart contracts, gradually merging into the Lego-style financial system of DeFi.

Currently, tokens like AAPLx and TSLAx have formed a preliminary liquidity network on the Solana chain, supporting continuous trading on decentralized exchanges like Raydium 24/7. This ecological layout has also spawned new profit models such as liquidity mining, where users can earn fee-sharing by providing liquidity for trading pairs, further enriching market participation dimensions [25].

3.2.2. Emerging market DeFi

The development of global financial technology shows significant regional differentiation. While leading platforms like Revolut and N26 compete fiercely in developed countries, decentralized finance protocols are experiencing explosive user growth in regions such as Africa, Latin America, and Southeast Asia [26]. The core driving force behind this differentiated development path lies in DeFi's low barrier to entry, requiring only internet connectivity and smartphones, perfectly matching the financial service needs of areas with weak traditional banking infrastructure.

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Market data corroborates the influence of this trend. On May 8, 2025, Ethereum (ETH), as a core infrastructure of the DeFi ecosystem, rose 3.2% on the Binance platform to $3150, with 24-hour trading volume surging 18% to $12.4 billion. During the same period, mainstream DeFi protocol tokens like Uniswap (UNI) and Aave (AAVE) rose 4.1% and 3.8%, reaching prices of $8.25 and $92.50, reflecting market recognition of this growth logic [26].

On-chain data further verifies the contribution of emerging markets. As of May 8, 2025, at 16:00 UTC, the total value locked (TVL) in global DeFi protocols increased by 5.7% from the previous day to $98.3 billion, marking the largest single-day increase in nearly six months. Notably, this growth exhibits a clear interconnected effect—during the same period, the stock price of Nubank (NU), a representative company of emerging market fintech listed on the NYSE, slightly increased by 1.5% to $12.30, indicating the potential for collaborative development between traditional fintech and DeFi in emerging markets.

For market participants, this trend creates cross-market arbitrage opportunities. Taking the ETH/BTC trading pair as an example, on May 8, 2025, at 15:00 UTC, the trading pair rose 2.1% to 0.052 BTC, with its volatility showing significant correlation with DeFi activity in emerging markets, providing traders with new strategic targets.

4. Conclusion

This study focuses on the adaptability of decentralized trading systems within quantitative strategies, deriving the following core findings through technical architecture analysis, strategy verification, and case studies:

Establishment of a Quantitative Adaptation Framework:

At the base layer blockchain level, Solana, with its 65k TPS high throughput and ≤400ms low latency, serves as the core platform for high-frequency arbitrage strategies; Ethereum Layer 2 (e.g., zk-Rollup) adapts to medium-frequency trend-following strategies by compressing latency to 50ms and reducing costs by 100 times.

At the DEX architecture level, order book DEXs (e.g., dYdX) achieve 50ms-level latency and leverage functionality through "off-chain matching + on-chain settlement," supporting high-frequency leveraged arbitrage; AMM DEXs (e.g., Uniswap V3) enhance capital efficiency by 400% through concentrated liquidity design, optimizing market-making strategy returns.

At the on-chain tools level, whale behavior tracking tools (e.g., Nansen) and smart contract trigger mechanisms (e.g., Aave) reduce strategy drawdown by 20% and volatility by 15% through leading indicators and automated execution.

Validation of the Feasibility and Advantages of Decentralized Design in Quantitative Scenarios:

The cost of cross-chain arbitrage via DEX (0.05%) is only 1/4 of that of CEX, and the liquidity concentration design of Uniswap V3 enhances market-making yields by 4 times.

The immutability of on-chain data avoids the interference of false trading volumes seen in CEX, leading to a 20% higher return for on-chain arbitrage strategies on Polygon in 2023 compared to CEX.

Risk Resistance: The decentralized architecture eliminates single points of failure, as demonstrated by Aave's smart contract liquidation mechanism, which maintained system stability during the 2022 cryptocurrency winter.

However, this study cannot avoid some limitations:

Insufficient depth of emerging market research: Although DeFi applications in emerging markets like Southeast Asia (e.g., Philippines PDAX) show cost advantages (with cross-border payment costs reduced by 50%), the research primarily focuses on phenomenon descriptions, lacking in-

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depth analysis of local regulatory environments, user behavior characteristics, and the adaptability of quantitative strategies.

Need for stronger academic support: The field of decentralized quantitative strategies is still rapidly developing, with limited academic theories and empirical studies regarding emerging markets and cross-chain collaboration. Existing conclusions largely depend on industry reports and case data, necessitating more interdisciplinary research (e.g., incorporating behavioral finance) to provide theoretical support.

Thus, the future study will focus on firstly, optimizing market adaptability of the framework. For effective markets (e.g., U.S. stocks), inefficient markets (e.g., cryptocurrencies), and emerging markets, refine the matching rules of "base layer public blockchain - strategy type," for example, designing lightweight blockchain adaptation solutions with low gas fees and high compliance for emerging markets. Secondly, deepening unique scenarios in emerging markets. Combining the characteristics of financial infrastructure in regions like Southeast Asia, research localized quantitative strategies (e.g., on-chain arbitrage based on mobile payment scenarios) and explore collaborative paths between decentralized systems and local regulatory frameworks.

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