Exploiting the Gaps: Cross-Exchange Arbitrage Opportunities in Illiquid Cryptocurrency Markets

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Abstract

This paper investigates arbitrage opportunities across illiquid cryptocurrency markets using order book data from 15 exchanges during May 2023. We identify 47 altcoins with daily volume under $100,000 that exhibited price discrepancies exceeding 5% for more than 30 minutes. Our analysis reveals that after accounting for transaction costs and slippage, triangular arbitrage yields an average 1.2% net return per successful trade, with execution probabilities varying from 12-28% depending on exchange pairs. The most profitable opportunities occurred in BTC trading pairs on smaller Asian exchanges during off-peak hours.

1 Introduction

Illiquid cryptocurrency markets present unique arbitrage opportunities due to fragmented liquidity and slow price discovery. Unlike efficient markets where arbitrage is quickly eliminated, crypto markets exhibit persistent price discrepancies, particularly for low-cap altcoins with market capitalizations below $50 million. These smaller cryptocurrencies often lack the institutional attention and automated trading systems that quickly eliminate price differences in major tokens like Bitcoin and Ethereum.

The most significant arbitrage opportunities arise in exotic trading pairs, such as BTC/DOGE rather than the more common USDT/DOGE pairs. These unconventional pairings create additional complexity in price discovery mechanisms, as traders must navigate multiple conversion steps to realize profits. Furthermore, regional exchanges with limited API access contribute to market fragmentation by creating information asymmetries and technical barriers that prevent efficient price convergence across platforms.

2 Data and Methodology

2.1 Data Collection

We collected 1-minute snapshots of order books for 150 illiquid pairs from major cryptocurrency exchanges. Our data collection focused on exchanges with varying levels of liquidity and geographic distribution to capture a comprehensive view of arbitrage opportunities. BitMart provided the largest sample with 32 trading pairs, followed by LBank with 28 pairs and Hotbit with 25 pairs. KuCoin and Gate.io contributed 23 and 18 pairs respectively, while the remaining 24 pairs were distributed across smaller exchanges.

Table 1: Exchange Coverage

Exchange	Number of Pairs
BitMart	32
LBank	28
Hotbit	25
KuCoin	23
Gate.io	18
Others	24

This data collection approach allowed us to capture the full spectrum of arbitrage opportunities across different exchange tiers. The minute-level granularity was chosen to balance computational efficiency with the ability to detect short-lived arbitrage windows that characterize illiquid markets.

2.2 Arbitrage Detection

We implemented a systematic approach to identify arbitrage opportunities using mathematical conditions that account for market inefficiencies. Our primary detection algorithm searches for triangular arbitrage opportunities where the ratio of ask prices to bid prices across exchange pairs falls below 0.95, indicating a potential 5% or greater profit margin before transaction costs.

$$\exists \quad \frac{\text{Ask}_A}{\text{Bid}_B} < 0.95 \quad \text{for} \quad A \to B \to C \to A \tag{1}$$

To ensure the validity of detected opportunities, we required that price spreads persist for at least 5 minutes. This threshold accounts for typical exchange latency and API delays, filtering out false signals that might appear due to temporary data synchronization issues. The persistence requirement also helps identify genuine market inefficiencies rather than fleeting technical glitches.

3 Empirical Results

Our analysis revealed several key patterns in arbitrage opportunity duration and execution characteristics. The majority of profitable arbitrage windows, approximately 68%, lasted between 5 and 15 minutes, providing a reasonable timeframe for manual or semi-automated execution. This duration suggests that while markets are not perfectly efficient, they do eventually correct price discrepancies through natural trading activity.

Slippage analysis showed that average market impact reached 1.8% for orders of $500, which represents a significant portion of potential arbitrage profits. This slippage occurs due to the shallow order books characteristic of illiquid markets, where even modest trade sizes can move prices substantially. The slippage measurements were consistent across different exchange pairs, suggesting this is a fundamental constraint rather than an exchange-specific issue.

Withdrawal delays emerged as the primary operational challenge, causing 42% of failed arbitrage attempts. These delays stem from exchange security protocols, blockchain network congestion, and manual approval processes that can extend settlement times

beyond the arbitrage window. The high failure rate due to withdrawal issues highlights the importance of maintaining adequate balances across multiple exchanges to enable immediate execution.

4 Risk Factors

4.1 Liquidation Risk

Failed arbitrage attempts led to unwanted inventory accumulation, creating additional risk exposure for traders. When arbitrage strategies fail to complete the full cycle, traders are left holding positions in potentially volatile cryptocurrencies that may decline in value. Our inventory risk metric quantifies this exposure by calculating the mark-to-market loss from entry prices to current market values.

$$IR = \sum_{i=1}^{n} \left(\frac{P_{\text{entry}} - P_{\text{current}}}{\times} Q_i \right) \tag{2}$$

The inventory risk analysis revealed an average loss of $23.50 per failed $500 arbitrage attempt, representing approximately 4.7% of the intended trade size. This risk becomes particularly acute in illiquid markets where unwinding positions can be difficult and costly. The inventory risk metric serves as a crucial consideration for position sizing and risk management in arbitrage strategies.

5 Conclusion

While cross-exchange arbitrage in illiquid crypto markets shows theoretical promise, practical implementation faces significant hurdles that limit profitability. Exchange withdrawal limits create artificial barriers to capital movement, preventing traders from quickly repositioning funds to capture arbitrage opportunities. These limits vary significantly across exchanges and can change without notice, making systematic arbitrage strategies difficult to implement at scale.

Network congestion on popular blockchain networks like Ethereum and Bitcoin can delay transaction confirmations, causing arbitrage windows to close before trades can be completed. During periods of high network activity, transaction fees can also spike dramatically, eroding potential profits from arbitrage strategies. Additionally, counterparty risk remains a constant concern when dealing with less established exchanges that may have limited regulatory oversight or financial backing.

Future research should explore automated cross-exchange settlement solutions that could address some of these operational challenges. Potential innovations include cross-exchange custody services, automated rebalancing protocols, and integration with decentralized finance platforms that could reduce settlement times and counterparty risks. These technological developments may eventually make systematic arbitrage strategies more viable in illiquid cryptocurrency markets.

References

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