



# Analysis of Market Dynamics of Crypto Exchanges: A Comparative Study of CEX and DEX Markets

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## Motivation & Problem

Centralized exchanges (CEXs) provide deep liquidity and low-latency orderbooks, while decentralized exchanges (DEXs) execute on-chain via AMMs with self-custody and transparency. These structural differences create measurable gaps in **price discovery**, **execution quality**, and **transaction costs**.

**Goal:** Build an end-to-end system that monitors CEX and DEX venues in real time and quantifies: deviation dynamics, lead-lag behavior, and slippage characteristics.

## Data Sources & Scope

**CEX feeds (WebSocket):** Coinbase, MEXC, Binance, Gate.io, OKX, Bybit, HTX, KuCoin.

**DEX feeds (on-chain events):** Uniswap V2 and Uniswap V3 Swap events.

- Chains used in analysis: Ethereum + BSC
- Pairs: BTC/USDT, ETH/USDT, BNB/USDT
- DEX listener capability: multi-chain configurable (additional networks supported via configuration)

**Dataset size (placeholder):** #CEX updates = \_\_\_\_, #DEX swaps = \_\_\_\_, period = \_\_\_\_.

## Contributions

- Multi-exchange CEX price index (volume-weighted reference price)
- Real-time DEX swap capture (Uniswap V2/V3 on Ethereum/BSC)
- Deviation & lead-lag analysis between CEX index and DEX execution
- Slippage characterization (theoretical AMM impact + empirical distributions)

## System Overview

**Pipeline:** Two real-time streams run in parallel: (i) CEX tickers → price index, and (ii) DEX swaps from on-chain events. Both are stored, then joined to compute deviations and run analytics.

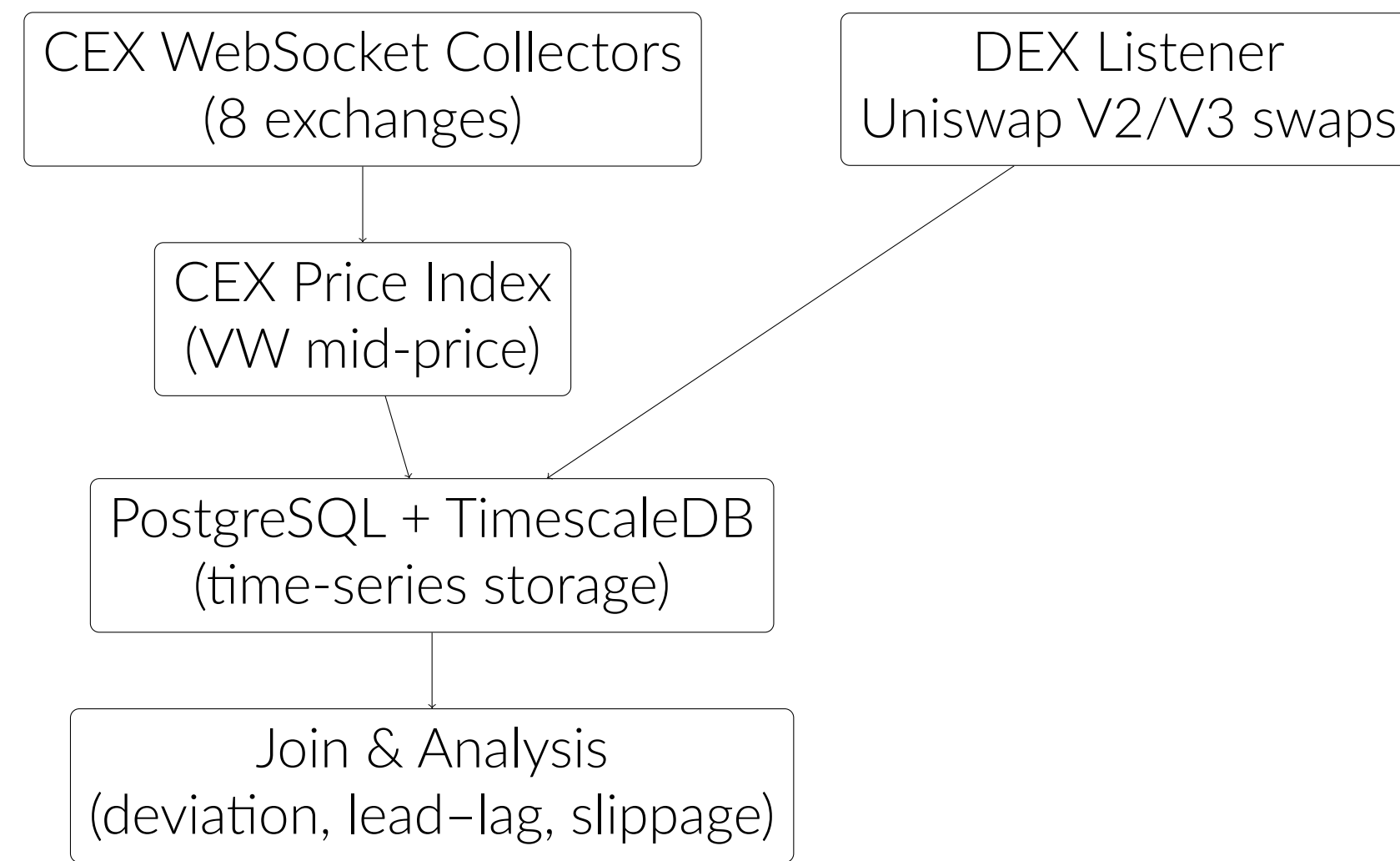


Figure 1. High-level architecture (schematic).

## Methodology (Core Metrics)

CEX reference price (index):

$$\text{price\_index}(t) = \frac{\sum_i \text{mid}_i(t) \cdot \text{vol}_i}{\sum_i \text{vol}_i}, \quad \text{mid}_i(t) = \frac{\text{bid}_i(t) + \text{ask}_i(t)}{2}$$

Deviation per DEX trade:

$$\text{deviation} = \frac{\text{DEX\_price} - \text{CEX\_index}}{\text{CEX\_index}} \times 100\%$$

**Lead-lag:** cross-correlation of log returns over lags  $\tau \in [-60s, +60s]$ .

**Slippage (V2 theoretical):**

$$\Delta y = y - \frac{xy}{x + \Delta x}, \quad \text{slippage} = \left| 1 - \frac{\Delta y / \Delta x}{y/x} \right|$$

## Implementation

- Collectors: Go (price-index/, dex-prices/)
- Storage: PostgreSQL 16 + TimescaleDB (database/)
- Analysis: Python (analysis/)
- Dashboard: Streamlit (price-index/dashboard.py)

## Results (Placeholders)

Placeholder: CEX vs DEX deviation time-series (BTC/USDT, ETH/USDT, BNB/USDT)

Figure 2. Deviation over time (placeholder).

Placeholder: Lead-lag CCF plot (peak lag and correlation per pair)

Figure 3. Lead-lag cross-correlation (placeholder).

Placeholder: Slippage vs trade size (P50/P90/P99)

Figure 4. Slippage curves (placeholder).

## Key Findings (Fill with final numbers)

- Deviation distribution:** median = \_\_\_\_ bps, P95 = \_\_\_\_ bps
- Lead-lag:** CEX leads DEX by \_\_\_\_ seconds (typical), varies by volatility
- Slippage:** grows nonlinearly with size; tails dominated by large trades / adverse ordering

## Takeaways

- CEXs provide a fast reference price; DEX execution quality depends strongly on pool liquidity.
- Cross-venue deviation and lead-lag measurements quantify price discovery and convergence.
- A unified pipeline enables reproducible monitoring and retrospective analysis.

## References

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