Kaiko Indices

Kaiko US Equity & ETF Reference Rates

Rulebook

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Version 1.0.0

www.kaiko.com

About Kaiko Indices

Kaiko Indices offers institutional-grade rates and indices, setting the standard for reliability and transparency in the digital asset market. As a regulated Benchmark Administrator under the EU BMR framework and compliant with IOSCO principles, we empower exchanges, asset managers, and financial institutions with trusted data solutions that support robust settlement and risk management practices.

Version History

Version	Publication Date	Comments
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1. Introduction

This document outlines the methodology of the Kaiko US Equity & ETF Reference Rates (the "Kaiko Equity Rates"). These rates are designed to provide robust, manipulation-resistant, and transparent reference prices for individual U.S. equities and index ETFs, supporting the creation of derivative products that require continuous reference pricing.

The methodology ensures reliable, manipulation-resistant, and transparent price formation by leveraging high-quality market data from US equity markets. This framework addresses key challenges, including comprehensive market coverage and off-market hours pricing, providing a robust foundation for derivative products that require continuous reference pricing. The approach combines best-in-class data sources with sophisticated aggregation methodologies to produce index prices that accurately reflect fair market value across different trading sessions and market conditions. By applying consistent, rules-based calculations, Kaiko's Methodology delivers reference prices suitable for use in liquidation mechanisms, funding rate calculations, and margin determinations within perpetual futures trading environments.

2. Review Calendar

2.1 Scheduled Review

Rebalancing is a scheduled, regular process designed to ensure that the Kaiko Rates provides the most relevant price data feeds and comply with the methodology detailed in this document.

All families of Kaiko Rates will follow the same quarterly rebalancing calendar (March, June, September and December) with cut-off and effective dates structuring the data collection and processing periods followed by publication periods (the calendar dates and weekdays do not account for any holidays).

Event	Date	Description	Example with June 2024 Review
Cut-off Date	Last day of the month preceding the Rebalancing Month.	Data collection for composition determination stops on that day.	31st of May, 2024
Effective Date	Monday after the third Friday of the Review Month.	Changes becomes effective.	24th of June, 2024

2.2 Extraordinary Review

On the basis of its qualified and expert judgement, Kaiko reserves the right to modify the rate design during the extraordinary review. Such extraordinary event would happen if the underlying asset has been found to experience an action such as:

- Fraud
- Market manipulation
- Significant loss of volume or liquidity

In such cases, the Kaiko Index Oversight Committee (IOC) will publish its findings and prove the design change within 3 days after the initial public communication.

3. Methodology

3.1 Data Sources

3.1.1 Asset Coverage

The Kaiko Equity Rates provide coverage across key segments of the equities market, including single US stocks and Index Exchange Traded Funds(ETFs). Coverage extends to all NMS-listed U.S. equities and major U.S. equity index ETFs demonstrating sufficient liquidity and data quality.

3.1.2 Primary Data Source

The Kaiko Equity Rates leverages the Quanthouse NBBO Securities Information Processor (SIP) feed as its primary data source. The feed delivers comprehensive coverage of all National Market System (NMS)-listed U.S. equities, providing the National Best Bid and Offer (NBBO) across all protected trading venues. This real-time, sub-second feed provides high-quality market data from major U.S. equity exchanges including Nasdaq, Arca (ICE-NYSE), and additional equity trading venues. Each update contains detailed quote information reflecting the most competitive bid and offer prices across the national market, ensuring accurate and transparent representation of market activity.

Kaiko implements continuous data quality monitoring to validate feed integrity, including real-time checks for data completeness, recency, accuracy, and anomaly detection to ensure the reliability of the equity rates calculations.

3.1.3 Extended Hours Coverage

To ensure continuous pricing suitable for 24/7 derivative products, the methodology integrates overnight trading data sourced from the Quanthouse Blue Ocean Alternative Trading System (BOATS) feed. BOATS provides overnight market coverage for select NMS-listed U.S. equities, delivering real-time venue-level Best Bid and Offer (BBO) data between 8:00 PM and 4:00 AM ET. This supplementary feed enhances market continuity by capturing trading activity outside of regular U.S. market hours, supporting seamless reference price computation across global trading sessions.

The combined feeds provide continuous 24/7 coverage. The table below summarizes the session structure and data sources used in the Kaiko Equity Rates methodology.

Session	Hours (ET)	Data Source
Early Hours	4:00 AM – 9:30 AM	NBBO SIP
Regular Hours	9:30 AM – 4:00 PM	NBBO SIP
Late Hours	4:00 PM – 8:00 PM	NBBO SIP
Overnight Hours	8:00 PM – 4:00 AM	BOATS

3. Methodology

3.2 Rates Calculation

The aggregation methodology consists of splitting the calculation window into equal-size time partitions and, for each of them, extracting the most representative price to use in the final rate. The methodology operates on all available data sources, transforming the BBO updates into a final equity rate.

3.2.1 Microprice Computation

A microprice is computed at each BBO update to provide a continuous estimate of the prevailing fair value. Unlike the simple mid-price, which assigns equal weight to the bid and ask quotes, the microprice accounts for the relative quoted size on each side of the order book.

$$\text{Microprice} = \frac{\text{Best Bid} \times \text{Bid Size} + \text{Best Ask} \times \text{Ask Size}}{\text{Bid Size} + \text{Ask Size}}$$

3.2.2 Liquidity Weight

For each microprice observation, a liquidity weight is assigned to represent the reliability and robustness of that observation. This weight captures the average depth available at the top of the order book, emphasizing price updates supported by stronger liquidity .

$$\text{Liquidity Weight} = \frac{\text{Bid Size} + \text{Ask Size}}{2}$$

3.2.3 Rate Aggregation

The final equity rate is computed using a time-weighted aggregation of volume-weighted medians, following Kaiko's Digital Asset Rates methodology, where the microprice serves as the input measure and liquidity weight is applied as the aggregation factor.

This multi-stage aggregation framework stabilizes short-term noise through median-based smoothing, mitigates the influence of outliers by emphasizing central market values, remains responsive to genuine market movements via time-weighting, and enhances manipulation resistance by reducing reliance on single-point observations.

1. Step-by-step Methodology

1. **Data Collection**: At calculation time, end of each publication interval for real-time and at set times for daily fixings, collect all microprices in the calculation window.
2. **Partition Creation**: Divide the calculation window into equal time-based partitions (e.g., a 1-hour calculation window divided into 10 partitions of 6 minutes each).
3. **Partition-level Calculation**: Calculate the Volume-Weighted Median for each partition using liquidity weight. This method provides inherent resistance to outliers and ensures robust price representation within each time segment.
4. **Time-weighting application**: Assign time-based weights to each partition's Volume-Weighted Median, with higher weights applied to more recent partitions to reflect current market conditions.
5. **Final Aggregation**: Aggregation of those weighted prices (e.g., 10 weighted prices aggregated on 1h calc. window) to derive the reference price for this publication event.

3. Methodology

3.2 Rates Calculation

3.2.3 Rate Aggregation

2. Input

- t — The timestamp at which the fixing price (FP) is calculated
- S_{wind} — Size of the calculation period for which trades are collected and aggregated.
- S_{part} — Size of each partition in the calculation window.
- K — The number of partitions is an integer calculated as S_{wind}/S_{part}
- k — k-th partition
- I_k — List of trades included in partition k and ordered by ascending price.
- p_i^k — i-th trade price in the k-th partition (price-ordered distribution).
- v_i^k — i-th trade volume in the k-th partition (price-ordered distribution).
- VWM_k — Volume-weighted median of the k-th partition.
- WP_t — Window price (WP) at time t.

3. Volume-Weighted Median

$$VWM_k = p_j^k \text{ where } j \text{ satisfies } \sum_{i=0}^{j-1} v_i^k < \frac{\sum_{i=1}^{I_k} v_i^k}{2} \text{ and } \sum_{i=j+1}^{I_k} v_i^k \leq \frac{\sum_{i=1}^{I_k} v_i^k}{2}$$

$$\text{If } \exists\ j : v_j^k > \frac{\sum_{i=1}^{I_k} v_i^k}{2} \text{ then } VWM_k = p_j^k$$

$$\text{If } \exists\ j : \sum_{i=j+1}^{I_k} v_i^k = \frac{\sum_{i=1}^{I_k} v_i^k}{2} \text{ then } VWM_k = \frac{p_j^k + p_{j+1}^k}{2}$$

4. Window Price

$$FP_T = \sum_{k=1}^{K} (VWM_k \times \overline{w_k}) \quad \text{where} \quad \overline{w_k} = \frac{w_k}{\sum_j w_j}, \quad w_k = \frac{1}{K} \sum_{j=1}^{k} 1_{j \leq k}$$

3. Methodology

3.2 Rates Calculation

3.2.4 Data Gaps

Missing Data
At the time of the calculation (t), some relevant transactions may be missing for an array of reasons. If no relevant data are recorded on the relevant partition, the corresponding partition is excluded from the calculation and weights are adjusted accordingly. If no relevant data are recorded in the entire calculation window, the price is not published.

Delayed Data
If for any reason Kaiko was unable to retrieve any relevant data at the calculation time, the corresponding partition is excluded from the calculation.

Spurious Data
If for any reason any underlying data were identified as potentially suspect within a partition, such transactions may be adjusted to disregard the spurious data.

3. Methodology

3.3 Kaiko US Equity & ETF Reference Rates

3.3.1. Single US Stock Rates

The Kaiko Equity Rates are designed to publish robust prices for individual U.S. stocks that accurately reflect fair market value across all major trading sessions. By processing best bid and ask data from the underlying sources, the methodology computes liquidity-weighted microprices and applies the aggregation framework to compute real-time and fixing publications. Coverage extends to all NMS-listed U.S. equities demonstrating sufficient liquidity and data quality across the underlying venues.

3.3.2. Index ETF Rates

Kaiko Equity Rates are published for major U.S. indices by leveraging highly liquid exchange-traded funds (ETFs) that track the underlying benchmarks. Rather than computing the rate directly from constituent stocks, the methodology utilizes a reference ETF to provide efficient, continuous, and transparent price discovery across all major trading sessions. This ETF-based approach simplifies data requirements, inherently accounts for index rebalancing and corporate actions, and ensures high reliability through instruments that represent real-time market consensus on index value.

By processing best bid and ask updates of the selected ETF, the methodology computes liquidity-weighted microprices and applies the aggregation framework to compute real-time and fixing publications. Coverage extends to major U.S. equity index ETFs demonstrating sufficient liquidity and data quality.

4. Publication Events

Each rate is composed of two types of publication events: real-time and fixing publications. The Kaiko Equity Rates adopt a static parameter configuration, differing from the periodically reviewed parameters of the Digital Asset Rates. This ensures consistent computation logic and comparability over time, reflecting the continuous nature of the underlying market data.

4.1 Real-Time Publications

Real-time publications are events that occur every second to support continuous, high-frequency pricing applications. These publications are available 24/7 during all active trading sessions, including Early Hours, Regular Hours, Late Hours, and Overnight Hours.

Parameters:

- Calculation window: 15 seconds
- Partition size: 3 seconds
- Publication frequency: 1 second

4.2 Fixing Publications

Fixing publications are defined as recurring events that occur at specific times corresponding to the close of distinct U.S. trading sessions. Each fixing provides a standardized reference point for valuation, settlement, and performance benchmarking across different market sessions.

Parameters:

- Calculation window: 300 seconds
- Partition size: 30 seconds
- Publication frequency: once a day

The following table outlines the standardized fixing times and corresponding market sessions used for Kaiko Equity Rates publications.

Fixing	Time (ET)	Description
Early Hours Close	9:30 AM	End of pre-market session
Regular Hours Close	4:00 PM	Official market close
Late Hours Close	8:00 PM	End of after-hours session
Overnight Close	4:00 AM	End of overnight session

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