Asia Index Pvt. Ltd.

Index Mathematics *Methodology*

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Introduction

This document covers the mathematics of equity index and other quantitative rules-based calculations and assumes some acquaintance with mathematical notation and simple operations. The calculations are presented principally as equations, which have largely been excluded from the individual index methodologies, with examples or tables of results to demonstrate the calculations.

Different Varieties of Equity Indices

Asia Index Private Limited's (AIPL) index calculation and corporate action treatments vary according to the categorization of the indices. At a broad level, indices are defined into two categorizations; Market Capitalization Weighted and Non-Market Capitalization Weighted Indices.

A majority of AIPL's equity indices are market capitalization weighted and float-adjusted, where each stock's weight in the index is proportional to its float-adjusted market value. AIPL also offers capped versions of a market capitalization weighted index where single index constituents or defined groups of index constituents, such as sector or geographical groups, are confined to a maximum weight.

Non-market capitalization weighted indices include those that are not weighted by float-adjusted market capitalization and generally are not affected by notional market capitalization changes resulting from corporate events. Examples include indices that apply equal weighting, factor weighting such as dividend yield or volatility, strategic tilts, thematic weighting, or other alternative weighting schemes.

AIPL offers a variety of indices and index attribute data calculated according to various methodologies which are covered in this document:

- Market Capitalization Indices:
    - Market-capitalization indices – where constituent weights are determined either by total or float-adjusted market capitalization.
    - Capped market-capitalization indices − where single index constituents or defined groups of index constituents, such as sector or geographical groups, are confined to a maximum index weight.
- Non-Market Capitalization Indices:
    - Price weighted indices − where constituent weights are determined solely by the prices of the constituent stocks in the index.
    - Equal weighted indices − where each stock is weighted equally in the index.
- Derived Indices:
    - Total return indices − index level reflect both movements in stock prices and the reinvestment of dividend income.
    - Leveraged and inverse indices − which return positive or negative multiples of their respective underlying indices.
    - Weighted return indices − commonly known as index of indices, where each underlying index is a component with an assigned weight to calculate the overall index of indices level.
    - Indices that operate on an index as a whole rather than on the individual stocks − these include calculations of various total return methodologies and index fundamentals.
    - Dividend Point indices − which track the total dividend payments of index constituents.
    - Risk control, decrement, excess return, currency, currency hedged, domestic currency return, special opening quotation, turnover and fundamental data calculations.

The Index Divisor

The purpose of the index divisor is to maintain the continuity of an index level following the implementation of corporate actions, index rebalancing events, or other non-market driven actions.

The simplest capitalization weighted index can be thought of as a portfolio consisting of all available shares of the stocks in the index. While one might track this portfolio's value in dollar terms, it would probably be an unwieldy number – for example, the BSE 500 float-adjusted market value is a figure in the crores of rupees. Rather than deal with ten or more digits, the figure is scaled to a more easily handled number (e.g., 32,000). Dividing the portfolio market value by a factor, usually called the divisor, does the scaling.

An index is not the same as a portfolio. For instance, when a stock is added to or deleted from an index, the index level should not jump up or drop down; while a portfolio's value would usually change as stocks are swapped in and out. To assure that the index's value, or level, does not change when stocks are added or deleted, the divisor is adjusted to offset the change in market value of the index. Thus, the divisor plays a critical role in the index's ability to provide a continuous measure of market valuation when faced with changes to the stocks included in the index. In a similar manner, some corporate actions that cause changes in the market value of the stocks in an index should not be reflected in the index level. Adjustments are made to the divisor to eliminate the impact of these corporate actions on the index value.

Supporting Documents

This methodology is meant to be read in conjunction with supporting documents providing greater detail with respect to the policies, procedures and calculations described herein. References throughout the methodology direct the reader to the relevant supporting document for further information on a specific topic. The list of the main supplemental documents for this methodology and the hyperlinks to those documents is as follows:

Supporting Document	URL
AIPL Equity Index Policy	Equity Index Policy
AIPL's Float Adjustment Methodology	Float Adjustment Methodology

Capitalization Weighted Indices

Many of AIPL's equity indices are capitalization-weighted indices. Sometimes these are called value- weighted, or market cap weighted, instead of capitalization weighted. Examples include BSE SENSEX, BSE AllCap, BSE 100/200/500 indices, etc.

In the discussion below most of the examples refer to BSE 500 but apply equally to a long list of AIPL's cap-weighted indices.

Definition

The formula to calculate the BSE 500 is:

$$Index\ Level = \frac{\sum_i P_i * Q_i}{Divisor} \qquad (1)$$

The numerator on the right hand side is the price of each stock in the index multiplied by the number of shares used in the index calculation. This is summed across all the stocks in the index. The denominator is the divisor. If the sum in the numerator is INR 1,60,00,000 crores and the divisor is INR 500, the index level would be 32000.

This index formula is sometimes called a "base-weighted aggregative" method. The formula is created by a modification of a *LasPeyres* index, which uses base period quantities (share counts) to calculate the price change. A *LasPeyres* index would be:

$$Index = \frac{\sum_i P_{i,1} * Q_{i,o}}{\sum_i P_{i,0} * Q_{i,o}} \qquad (2)$$

In the modification to (2), the quantity measure in the numerator, Q_0, is replaced by Q_1, so the numerator becomes a measure of the current market value, and the product in the denominator is replaced by the divisor which both represents the initial market value and sets the base value for the index. The result of these modifications is equation (1) above.

Adjustments to Share Counts

AIPL's market cap-weighted indices are float-adjusted – the number of shares outstanding is reduced to exclude closely held shares from the index calculation because such shares are not available to investors.

For more information on shares outstanding, please refer to Asia Index Private Limited's Equity Index Policy Methodology.

AIPL's rules for float adjustment are described in more detail in *Asia Index Private Limited's Float Adjustment Methodology* or in some of the individual index methodology documents. As discussed there, for each stock AIPL calculates an Investable Weight Factor (IWF) which is the percentage of total shares outstanding that are included in the index calculation.

When the index is calculated using equation (1), the variable Q_i is replaced by the product of outstanding shares and the IWF:

$$Q_i = IWF_i * Total\ Shares_i \qquad (3)$$

At times there are other adjustments made to the share count to reflect foreign ownership restrictions or to adjust the weight of a stock in an index. These are combined into a single multiplier in place of the IWF in equation (3). In combining restrictions, it is important to avoid unwanted double counting. Let FA represent the fraction of shares eliminated due to float adjustment, FR represent the fraction of shares excluded for foreign ownership restrictions and IS represent the fraction of total shares to be excluded based on the combination of FA and FR.

If FA > FR then IS = 1- FA

If FA < FR then IS = 1-FR

and equation (3) can be written as:

$$Q_i = IS_i * Total\ Shares_i$$

Note that any time the share count or the IWF is changed, it will be necessary to adjust the index divisor to keep the level of the index unchanged.

Divisor Adjustments

The key to index maintenance is the adjustment of the divisor. Index maintenance – reflecting changes in shares outstanding, corporate actions, addition or deletion of stocks to the index – should not change the level of the index. If the BSE 500 closes at 2000 and one stock is replaced by another, after the market close, the index should open at 2000 the next morning if all of the opening prices are the same as the previous day's closing prices. This is accomplished with an adjustment to the divisor.

Any change to the stocks in the index that alters the total market value of the index while holding stock prices constant will require a divisor adjustment. This section explains how the divisor adjustment is made given the change in total market value. The next section discusses what index changes and corporate actions lead to changes in total market value and the divisor.

Equation (1) is expanded to show the stock being removed, stock *r*, separately from the stocks that will remain in the index:

$$Index\ Level_{t-1} = \frac{(\sum_i P_i * Q_i) + P_r Q_r}{Divisor_{t-1}} \qquad (4)$$

Note that the index level and the divisor are now labeled for the time period *t-1* and, to simplify this example, that we are ignoring any possible IWF and adjustments to share counts. After stock *r* is replaced with stock *s*, the equation will read:

$$Index\ Level_t = \frac{(\sum_i P_i * Q_i) + P_s Q_s}{Divisor_t} \qquad (5)$$

In equations (4) and (5) *t-1* is the moment right before company *r* is removed from and *s* is added to the index; *t* is the moment right after the event. By design, $Index\ Level_{t-1}$ is equal to $Index\ Level_t$. Combining (4) and (5) and re-arranging, the adjustment to the Divisor can be determined from the index market value before and after the change:

$$\frac{(\sum_i P_i * Q_i) + P_r Q_r}{Divisor_{t-1}} = Index\ Level = \frac{(\sum_i P_i * Q_i) + P_s Q_s}{Divisor_t}$$

Let the numerator of the left hand fraction be called MV_{t-l}, for the index market value at (*t-1*), and the numerator of the right hand fraction be called MV_t, for the index market value at time *t*. Now, MV_{t-1}, MV_t and $Divisor_{t-1}$ are all known quantities. Given these, it is easy to determine the new divisor that will keep the index level constant when stock *r* is replaced by stock *s*:

$$Divisor_t = (Divisor_{t-1}) * \frac{MV_t}{MV_{t-1}} \qquad (6)$$

As discussed below, various index adjustments result in changes to the index market value. When these adjustments occur, the divisor is adjusted as shown in equation (6).

In some implementations, including the computer programs used in AIPL's index calculations, the divisor adjustment is calculated in a slightly different, but equivalent, format where the divisor change is calculated by addition rather than multiplication. This alternative format is defined here. Rearranging equation (1) and using the term *MV* (market value) to replace the summation gives:

$$Divisor = \frac{MV}{Index\ Level}$$

When stocks are added to or deleted from an index there is an increase or decrease in the index's market value. This increase or decrease is the market value of the stocks being added less the market value of those stocks deleted; define *CMV* as the Change in Market Value. Recalling that the index level does not change, the new divisor is defined as:

$$Divisor_{New} = \frac{MV + CMV}{Index\ Level}$$

or

$$Divisor_{New} = \frac{MV}{IndexLevel} + \frac{CMV}{IndexLevel}$$

However, the first term on the right hand side is simply the Divisor value before the addition or deletion of the stocks. This yields the following:

$$Divisor_{New} = Divisor_{Old} + \frac{CMV}{IndexLevel} \qquad (7)$$

Note that this form is more versatile for computer implementations. With this additive form, the second term (*CMV/Index Level*) can be calculated for each stock or other adjustment independently and then all the adjustments can be combined into one change to the Divisor.

Necessary Divisor Adjustments

Divisor adjustments are made "after the close" meaning that after the close of trading the closing prices are used to calculate the new divisor based on whatever changes are being made. It is, then, possible to provide two complete descriptions of the index – one as it existed at the close of trading and one as it will exist at the next opening of trading. If the same stock prices are used to calculate the index level for these two descriptions, the index levels are the same.

With prices constant, any change that changes the total market value included in the index will require a divisor change. For cataloging changes, it is useful to separate changes caused by the management of the index from those stemming from corporate actions of the constituent companies. Among those changes driven by index management are adding or deleting companies, adjusting share counts and changes to IWFs and other factors affecting share counts.

Index Management Related Changes. When a company is added to or deleted from the index, the net change in the market value of the index is calculated and this is used to calculate the new divisor. The market values of stocks being added or deleted are based on the prices, shares outstanding, IWFs and any other share count adjustments. Specifically, if a company being added has a total market cap of INR 100 crores, an IWF of 85% and, therefore, a float-adjusted market cap of INR 85 crores, the market value for the added company used is INR 85 crore. The calculations would be based on either equation (6) or equation (7) above.

For most AIPL equity indices, IWFs and share counts updates are applied throughout the year based on rules defined in the methodology. Typically, small changes in shares outstanding are reflected in indices once a quarter to avoid excessive changes to an index. The revisions to the divisor resulting from these are calculated and a new divisor is determined. Equation (7) shows how the impact of a series of share count changes can be combined to determine the new divisor.

Corporate Action Related Changes.

For information on the treatment of corporate actions, please refer to AIPL's Equity Index Policy document. For more information on the specific treatment within an index family, please refer to that index methodology.

Capped Market Capitalization Indices

Definition

A capped market capitalization weighted index (also referred to as a capped market cap index, capped index or capped weighted index) is one where single index constituents or defined groups of index constituents are confined to a maximum weight and the excess weight is distributed proportionately among the remaining index constituents. As stock prices move the weights will shift and the modified weights will change. Therefore, a capped market cap weighted index must be rebalanced from time to time to re-establish the proper weighting. The methodology for capped indices follows an identical approach to market cap weighted indices except that the indices apply an additional weight factor, or "AWF", to adjust the float-adjusted market capitalization to a value such that the index weight constraints are satisfied. For capped indices, no AWF change is made due to corporate actions between rebalancings except for daily capped indices where the corporate action may trigger a capping. Therefore, the weights of stocks in the index as well as the index divisor will change due to notional market capitalization changes resulting from corporate events.

The overall approach to calculate capped market cap weighted indices is the same as in the pure marketcap weighted indices; however, the constituents' market values are re-defined to be values that will meet the particular capping rules of the index in question.

$$Index\ Level = \frac{Index\ MarketValue}{Divisor} \quad (1)$$

and

$$IndexMarketValue = \sum_i P_i * Shares_i * IWFi * FxRatei$$

To calculate a capped market cap index, the market capitalization for each stock used in the calculation of the index is redefined so that each index constituent has the appropriate weight in the index at each rebalancing date.

In addition to being the product of the stock price, the stock's shares outstanding, and the stock's float factor (IWF), as written above – and the exchange rate when applicable – a new adjustment factor is also introduced in the market capitalization calculation to establish the appropriate weighting.

$$AdjustedStockMarketValue_i = P_i * Shares_i * IWF_i * FxRate_i * AWF_i$$

where AWF_i is the adjustment factor of stock *i* assigned at each index rebalancing date, *t,* which adjusts the market capitalization for all index constituents to achieve the user-defined weight, while maintaining the total market value of the overall index.

The *AWF* for each index constituent, *i*, on rebalancing date, *t*, is calculated by:

$$AWF_{i,t} = \frac{CW_{i,t}}{W_{i,t}}$$

where $W_{i,t}$ is the uncapped weight of stock *i* on rebalancing date *t* based on the float-adjusted market capitalization of all index constituents; and $CW_{i,t}$ is the capped weight of stock *i* on rebalancing date *t* as determined by the capping rule of the index in question and the process for determining capped weights as described in Different Capping Methods below.

The index divisor is defined based on the index level and market value from equation (1). The index level is not altered by index rebalancings. However, since prices and outstanding shares will have changed since the last rebalancing, the divisor will change at the rebalancing.

So:

$$(Divisor)_{\text{after rebalancing}} = \frac{(Index\ Market\ Value)_{\text{after rebalancing}}}{(Index\ Value)_{\text{before rebalancing}}}$$

where:

$$Index\ Market\ Value = \sum_i P_i * Shares_i * IWF_i * FxRate_i * AWF_i$$

Corporate Actions and Index Adjustments

All corporate actions for capped indices affect the index in the same manner as in market capitalization weighted indices.

For more information on the treatment of corporate actions, please refer to Asia Index Private Limited's Equity Index Policy document.

Different Capping Methods

Capped indices arise due to the need for benchmarks which facilitate diversification rules. Capping may apply to single stock concentration limits or concentration limits on a defined group of stocks. At times, companies may also be represented in an index by multiple share class lines. In these instances, maximum weight capping will be based on company float-adjusted market capitalization, with the weight of multiple class companies allocated proportionally to each share class line based on its float-adjusted market capitalization as of the rebalancing reference date. Some common, but not an exhaustive list of, examples of the standard AIPL methodologies for determining the weights of capped indices using the most popular capping methods are described below.

Single Company Capping. In a single company capping methodology, no company in an index is allowed to breach a certain pre-determined weight as of each rebalancing period. The procedure for assigning capped weights to each company at each rebalancing is as follows:

1. With data reflected on the rebalancing reference date, each company is weighted by float-adjusted market capitalization.
2. If any company has a weight greater than X% (where X% is the maximum weight allowed in the index), that company has its weight capped at X%.
3. All excess weight is proportionally redistributed to all uncapped companies within the index.
4. After this redistribution, if the weight of any other company(s) then breaches X%, the process is repeated iteratively until no companies breach the X% weight cap.

Single Company and Concentration Limit Capping. In a single company and concentration limit capping methodology, no company in an index is allowed to breach a certain pre-determined weight and all companies with a weight greater than a certain amount are not allowed, as a group, to exceed a predetermined total weight. One example of this is 4.5%/22.5%/45% capping (B/A/C in the following example). No single company is allowed to exceed 22.5% of the index and all companies with a weight greater than 4.5% of the index cannot exceed, as a group, 45% of the index.

Method 1:

The procedure for assigning capped weights to each company at each rebalancing is as follows:

1. With data reflected on the rebalancing reference date, each company is weighted by float-adjusted market capitalization.
2. If any company has a weight greater than A% (where A% is the maximum weight allowed in the index), that company has its weight capped at A%.
3. All excess weight is proportionally redistributed to all uncapped companies within the index.
4. After this redistribution, if the weight of any other company(s) then breaches A%, the process is repeated iteratively until no companies breach the A% weight cap.
5. The sum of the companies with weight greater than B% cannot exceed C% of the total weight.
6. If the rule in step 5 is breached, all the companies are ranked in descending order of their weights and the company with the lowest weight that causes the C% limit to be breached is identified. The weight of this company is, then, reduced either until the rule in step 5 is satisfied or it reaches B%.
7. This excess weight is proportionally redistributed to all companies with weights below B%. Any stock that receives weight cannot breach the B% cap. This process is repeated iteratively until step 5 is satisfied or until all stocks are greater than or equal to B%.
8. If the rule in step 5 is still breached and all stocks are greater than or equal to B%, the company with the lowest weight that causes the C% limit to be breached is identified. The weight of this company is, then, reduced either until the rule in step 5 is satisfied or it reaches B%.
9. This excess weight is proportionally redistributed to all companies with weights greater than B%. Any stock that receives weight cannot breach the A% stock cap. This process is repeated iteratively until step 5 is satisfied.

For indices that use capping rules across more than one attribute, AIPL will utilize an optimization program to satisfy the capping rules. The stated objective for the optimization will be to minimize the difference between the pre-capped weights of the stocks in the index and the final capped weights. This is done by using an optimization procedure that chooses final weights in such a way to minimize the sum of the squared difference of capped weight and uncapped weight, divided by uncapped weight for each stock.

Method 2:

A second method of single company and concentration limit capping utilized by AIPL for assigning capped weights to each company at each rebalancing is as follows:

1. With data reflected on the rebalancing reference date, each company is weighted by float-adjusted market capitalization.
2. If either of the defined single-company or concentration-index-weight limits is breached, the float-adjusted market capitalization of all components is raised to a power such as the following:

   $$Index\ Market\ Cap_t = {W_t}^{1-0.01n}$$

   where:

   W_t = Float-adjusted market capitalization of component t.

   n = Number of capping iterations.

3. This process is repeated iteratively until the first iteration where the capping constraints are satisfied.

Non-Market Capitalization Weighted Indices

Definition

A non-market capitalization weighted index (also referred to as a non-market cap or modified market cap index) is one where index constituents have a user-defined weight in the index. Between index rebalancings, most corporate actions generally have no effect on index weights, as they are fixed through the processes defined below. As stock prices move, the weights will shift, and the modified weights will change. Therefore, a non-market cap weighted index must be rebalanced from time to time to reestablish the proper weighting.

The overall approach to calculate non-market cap weighted indices is the same as in the cap-weighted indices; however, the constituents' market values are set to a value to achieve a specific weight at each rebalancing that is divergent from a purely free-float-adjusted market capitalization weighting. Recall two basic formulae:

$$Index\ Level = \frac{Index\ MarketValue}{Divisor} \qquad (1)$$

and

$$IndexMarketValue = \sum_i P_i * Shares_i * IWFi * FxRatei$$

To calculate a non-market cap weighted index, the market capitalization for each stock used in the calculation of the index is redefined so that each index constituent has the appropriate user-defined weight in the index at each rebalancing date.

In addition to being the product of the stock price, the stock's shares outstanding, and the stock's float factor (IWF), as written above – and the exchange rate when applicable – a new adjustment factor is also introduced in the market capitalization calculation to establish the appropriate weighting.

$$AdjustedStockMarketValue_i = P_i * Shares_i * IWF_i * FxRate_i * AWF_i$$

where AWF_i is the adjustment factor of stock *i* assigned at each index rebalancing date, *t,* which adjusts the market capitalization for all index constituents to achieve the user-defined weight, while maintaining the total market value of the overall index.

The *AWF* for each index constituent, *i*, on rebalancing date, *t*, is calculated by:

$$AWF_{i,t} = \frac{Z}{FloatAdjustedMarketValue_{i,t}} * W_{i,t} \qquad (2)$$

where *Z* is an index specific constant set for the purpose of deriving the *AWF* and, therefore, each stock's share count used in the index calculation (often referred to as modified index shares). $W_{i,t}$ is the userdefined weight of stock *i* on rebalancing date *t*.

The index divisor is defined based on the index level and market value from equation (1). The index level is not altered by index rebalancings. However, since prices and outstanding shares will have changed since the last rebalancing, the divisor will change at the rebalancing.

So:

$$(Divisor)_{\text{after rebalancing}} = \frac{(Index\ Market\ Value)_{\text{after rebalancing}}}{(Index\ Value)_{\text{before rebalancing}}}$$

where:

$$Index\ Market\ Value = \sum_i P_i * Shares_i * IWF_i * FxRate_i * AWF_i$$

Corporate Actions and Index Adjustments

For information on the treatment of corporate actions, please refer to Asia Index Private Limited' Equity Index Policy document. For more information on the specific treatment within an index family, please refer to that index methodology.

Price Weighted Indices

Definition

In a price weighted index, constituent weights are determined solely by the prices of the constituent stocks. Shares outstanding are set to a uniform number throughout the index. Indices using this methodology will adjust the index divisor for any price impacting corporate action on one of its member stocks; this includes price adjustments, special dividends, stock splits and rights offerings. The index divisor will also adjust in the event of an addition to or deletion from the index.

All other index calculation details follow the standard divisor-based calculation methodology detailed in the previous *Capitalization Weighted Indices* section.

For information on the treatment of corporate actions, please refer to Asia Index Private Limited's Equity Index Policy document.

Equal Weighted Indices

Definition

An equal weighted index is one where every stock, or company, has the same weight in the index, and a portfolio that tracks the index will invest an equal amount in each applicable instrument. As stock prices move, the weights will shift, and exact equality will be lost. Therefore, an equal weighted index must be rebalanced from time to time to re-establish the proper weighting.[1]

The overall approach to calculate equal weighted indices is the same as in the cap-weighted indices; however, the constituents' market values are re-defined to be values that will achieve equal weighting at each rebalancing. Recall two basic formulae:

$$Index\ Level = \frac{Index\ MarketValue}{Divisor} \qquad (1)$$

and

$$IndexMarketValue = \sum_i P_i * Shares_i * IWFi * FxRatei$$

To calculate an equal weighted index, the market capitalization for each stock used in the calculation of the index is redefined so that each index constituent has an equal weight in the index at each rebalancing date. In addition to being the product of the stock price, the stock's shares outstanding, and the stock's float factor (IWF), as written above – and the exchange rate when applicable – a new adjustment factor is also introduced in the market capitalization calculation to establish equal weighting.

$$AdjustedStockMarketValuei = P_i * Shares_i * IWFi * FxRatei * AWFi \qquad (2)$$

where AWF_i (Additional Weight Factor) is the adjustment factor of stock *i* assigned at each index rebalancing date, *t,* which makes all index constituents modified market capitalization equal (and, therefore, equal weight), while maintaining the total market value of the overall index. The *AWF* for each index constituent, *i*, at rebalancing date, *t*, is calculated by:

$$AWF_{i,t} = \frac{Z}{N * FloatAdjustedMarketValue_{i,t}} \qquad (3)$$

where *N* is the number of stocks in the index and *Z* is an index specific constant set for the purpose of deriving the *AWF* and, therefore, each stock's share count used in the index calculation (often referred to as modified index shares).

The index divisor is defined based on the index level and market value from equation (1). The index level is not altered by index rebalancings. However, since prices and outstanding shares will have changed since the last rebalancing, the divisor will change at the rebalancing.

[1] In contrast, a cap-weighted index requires no rebalancing as long as there aren't any changes to share counts, IWFs, returns of capital, or stocks added or deleted.

So:

$$(Divisor)_{\text{after rebalancing}} = \frac{(Index\ Market\ Value)_{\text{after rebalancing}}}{(Index\ Value)_{\text{before rebalancing}}}$$

where:

$$Index\ Market\ Value = \sum_i P_i * Shares_i * IWF_i * FxRate_i * AWF_i$$

Modified Equal Weighted Indices

There are some equal weighted indices that place further restrictions on stocks included in the index. An example restriction might be a cap on the weight allocated to one sector or a cap on the weight of a single country or region in the index. The rules could also stipulate a maximum weight for a stock if the index applies additional liquidity factors (e.g., basket liquidity) when determining the index weights. In any of these situations, if a cap is applied to satisfy the restrictions, the excess weight leftover by the cap would be distributed equally amongst the uncapped companies.

Corporate Actions and Index Adjustments

For more information on the treatment of corporate actions, please refer to Asia Index Private Limited's Equity Index Policy document. For more information on the specific treatment within an index family, please refer to that index methodology.

Total Return Calculations

The preceding discussions were related to price indices where changes in the index level reflect changes in stock prices. In a total return index changes in the index level reflect both movements in stock prices and the reinvestment of dividend income. A total return index represents the total return earned in a portfolio that tracks the underlying price index and reinvests dividend income in the overall index, not in the specific stock paying the dividend.

The total return construction differs from the price index and builds the index from the price index and daily total dividend returns. The first step is to calculate the total dividend paid on a given day and convert this figure into points of the price index:

$$TotalDailyDividend = \sum_{i} Dividend_i * Shares_i \qquad (1)$$

Where *Dividend* is the dividend per share paid for stock *i* and *Shares* are the index specific shares. This is done for each trading day. $Dividend_i$ is generally zero except when it goes ex-dividend for a dividend payment.[2] Stocks may commonly issue dividends on a monthly, quarterly, semi-annual, or annual basis. Some stocks do not pay a dividend and *Dividend* is always zero. *TotalDailyDividend* is measured in INR. This is converted to index points by dividing by the divisor for the underlying price index:

$$IndexDividend = \frac{TotalDailyDividend}{Divisor} \qquad (2)$$

The next step is to apply the usual definition of a total return from a financial instrument to the price index. Equation (1) gives the definition, and equation (2) applies it to the index:

$$TotalReturn = \left(\frac{P_t + D_t}{P_{t-1}}\right) - 1$$

and

$$DTR_t = \left(\frac{IndexLevel_t + IndexDividend_t}{IndexLevel_{t-1}} - 1\right)$$

where the *TotalReturn* and the daily total return for the index (*DTR*) is stated as a decimal. The *DTR* is used to update the total return index from one day to the next:

$$Total\ ReturnIndex_t = (Total\ ReturnIndex_{t-1}) * (1 + DTR_t)$$

The Index Value for the Total Return Index can also be calculated as follows:

$Total\ Return\ Index_t = (Total\ Return\ Index_{t-1}) * (Price\ Return\ Index_t + Index\ Dividend) / Price\ Return\ Index_{t-1}$

[2] $Dividend_i$ can be negative if a dividend correction is applied to a particular stock. In such cases, a total return can have a value lower than the price return. For more information on dividend corrections please refer to *AIPL's Equity Indiex Policy Methodology*.

Post Ex-Dividend Adjustment: Total Return Calculation

When AIPL recognizes a regular dividend different than the final dividend amount confirmed by the company, or for specific markets where companies do not typically confirm cash dividend amounts prior to the ex-dates, AIPL may recognize a post ex-date dividend adjustment.

First, an estimated dividend is reinvested into the index on the dividend's Ex-Date, following the process defined in the *Total Return Calculation* section, where is the dividend is converted to index dividend points by dividing by the divisor for the underlying price index.

Second, a Post-Ex Dividend Adjustment is applied, determined by AIPL calculating the difference between the dividend amount recognized on the original ex-date and the actual dividend amount announced by the company. Once determined, the adjustment amount is applied, in dividend points, to all relevant indices using the following formula:

*Index Dividend Point Adjustment = (Ddt * Sat) / Divisor Ex-Date*

where:

Ddt = the difference between the original and actual dividend amounts. Foreign exchange conversion, if applicable, is based on the exchange rate on the ex-date, calculated as:

Correction Amount * *FX on the Reference Ex-Date*

where:

Correction Amount[3] = the dividend amounts relative to all the data as of the original dividend ex-date

Sat = Index shares on the Reference Ex-Date

The adjustment is added to the calculation of the Total Return indices on the dividend's effective date. If there are multiple dividend payments with an ex-date of the current day and/or multiple dividend adjustments, separate index dividend points are calculated for each dividend payment and aggregated on Index Dividend as follows:

$$TotalDailyDividend = \sum IndexDividendPointAdjustment + IndexDividend\ t$$

Risk Control Indices

Asia Index Private Limited's Risk Control Indices are designed to track the return of a strategy that applies dynamic exposure to an underlying index to control the level of volatility.

The index includes a leverage factor that changes based on realized historical volatility. If realized volatility exceeds the target level of volatility, the leverage factor will be less than one; if realized volatility is lower than the target level, the leverage factor may be greater than one, assuming the index allows for a leverage factor of greater than one. A given Risk Control Index may have a maximum leverage factor that cannot be exceeded. There are no guarantees that the index shall achieve its stated targets.

The return of the index consists of two components: (1) the return on the position in the underlying index and (2) the interest cost or gain, depending upon whether the position is leveraged or deleveraged.

A leverage factor greater than one represents a leveraged position, a leverage factor equal to one represents an unleveraged position, and a leverage factor less than one represents a deleveraged position. The leverage factor may change periodically, on a set schedule, or may change when volatility exceeds or falls below predetermined volatility thresholds.

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The formula for calculating the Risk Control Index is as follows:

Risk Control Index Return$_t$ =

$$K_{rb} * \left(\frac{Underlying\ Index_t}{Underlying\ Index_{rb}} - 1 \right) + (1 - K_{rb}) * \left[\prod_{i=rb+1}^{t} (1 + InterestRate_{i-1} * D_{i-1,i} / 360) - 1 \right] \quad (1)$$

The Risk Control Index Value at time *t* can, then, be calculated as:

RiskControlIndexValue$_t$ =

$$(RiskControlIndexValue_{rb}) * (1 + RiskControlIndex\ Return_t) \quad (2)$$

Substituting equation (1) into (2) and expanding yields:

Risk Control Index Value$_t$ =

$$Risk\ Control\ Index\ Value_{rb} * \left[1 + \left[K_{rb} * \left(\frac{Underlying\ Index_t}{Underlying\ Index_{rb}} - 1 \right) + (1 - K_{rb}) * \left[\prod_{i=rb+1}^{t} (1 + InterestRate_{i-1} * D_{i-1,i} / 360) - 1 \right] \right] \right] \quad (3)$$

Excess Return versions of Risk Control Indices are calculated as follow:

Risk Control ER Index Value$_t$ =

$$RiskControl\ ER\ Index\ Value_{rb} *$$
$$\left[1+\left[K_{rb}*\left(\frac{UnderlyingIndex_t}{UnderlyingIndex_{t-1}}-1\right)-K_{rb}*\left[\prod_{i=rb+1}^{t}\left(1+InterestRate_{t-1}*\frac{D_{i-1,i}}{360}\right)-1\right]\right]\right]$$

where:

UnderlyingIndex$_t$	= The level of the underlying index on day *t*
UnderlyingIndex$_{rb}$	= The level of the underlying index as of the previous
rebalancing date *rb*	= The last index rebalancing date[4]
K$_{rb}$	= The leverage factor set at the last rebalancing date, calculated as: *Min(Max K, Target Volatility/Realized Volatility$_{rb-d}$)*
Max K	= The maximum leverage factor allowed in the index
d	= The number of days between when volatility is observed and the rebalancing date (e.g., if *d* = 2, the historical volatility of the underlying index as of the close two days prior to the rebalancing date will be used to calculate the leverage factor *K$_{rb}$*)
Target Volatility	= The target level of volatility set for the index
Realized Volatility$_{rb-d}$	= The historical realized volatility of the underlying index as of the close of *d* trading days prior to the previous rebalancing date, *rb,* where a trading day is defined as a day on which the underlying index is calculated
Interest Rate$_{i-1}$	= The interest rate set for the index[5]

For indices that replicate a rolling investment in a three-month interest rate the above formula is altered to:

$$Risk\ Control\ Index\ Value_t = Risk\ Control\ Index\ Value_{rb} * \left[1+\left[K_{rb}*\left(\frac{Underlying\ Index_t}{Underlying\ Index_{rb}}-1\right)+(1-K_{rb})*\left[\prod_{i=rb+1}^{t}(1+InterestRate_{i-1})-1\right]\right]\right]$$

where:

$$InterestRate_{i-1} = \quad (D_{i-1,t}*IR3M_{i-1}-\left(IR3M_{i-1}-IR3M_{i-2}-D_{i-1,t}*(IR3M_{i-1}-IR2M_{i-1})*\left(\frac{1}{30}\right)\right)*90)/360$$

where:

D$_{i-1,t}$	= The number of calendar days between day *i-1* and day *t*
IR3M$_{i-1}$	= Three-month interest rate on day *i-1*
IR2M$_{i-1}$	= Two-month interest rate on day *i-1*[6]

[4] The inception date of each risk control index is considered the first rebalancing date of that index.

[5] The interest rate may be an overnight rate, such as SOFR or ESTR, or a daily valuation of a rolling investment in a three-month interest rate, or zero. A 360-day year is assumed for the interest calculations.

[6] Effective 12/03/2018, the interest rate for EUR-based Risk Control indices is a one-month rate instead of a two-month rate. Therefore, those indices' interest rate is depicted as: *IR2M$_{i-1}$* = One-month interest rate on day *i-1*.

For indices that are rebalanced daily, the leverage factor is not recalculated at the close of any index calculation day when stocks representing 15% or more of the total weight of the underlying index are not trading due to an exchange holiday. If *rb* is a holiday, then K_{rb} is calculated as follows:

This shows what the effect will be on *rb*, given that no adjustment of positions is allowed to occur on such days. The leverage factor will adjust solely to account for market movements on that day.

For periodically rebalanced risk control indices, K_{rb} is calculated at each rebalancing and held constant until the next rebalancing.

For large position moves, some investors like to rebalance risk control indices intra-period, when the periodicity is longer than daily. This feature is incorporated in the risk-control framework by introducing a barrier, K_b, on the leverage factor. Intra-period rebalancing is allowed only if the absolute change of the equity leverage factor K_t, at time *t*, is larger than the barrier K_b from the value at the last rebalancing date.

The equity leverage factor K_t is calculated as:

$$K_t = Min(Max\ K, Target\ Volatility/Realized\ Volatility_{t-d})$$

If no barrier is provided for the index, then intra-period rebalancing is not allowed.

Dynamic Rebalancing Risk Control Index

The index calculates the theoretical leverage factor on daily basis. If the difference between the theoretical leverage factor and the leverage factor on the last rebalancing date is less than the Minimum Daily Allocation Change, the index will not rebalance.

The theoretical leverage factor is determined as:

thK_t = the theoretical leverage factor on day *t*, calculated daily as:

$$thK_t = Min\left(Max\ K, \frac{Target\ Volaility}{Realized\ Volatility_{t-d}}\right)$$

where:

d = Lag to Rebalancing Date, defined as the number of days between when volatility is observed and the date which the theoretical leverage factor is calculated for (e.g., if *d* = 2, the historical volatility of the underlying index as of the close two days prior to the date which the theoretical leverage factor is calculated for will be used to calculate the leverage factor thK_t)

The trade decision is based on the difference between the theoretical leverage factor and the leverage factor on the last rebalancing date:

If $|thK_t - K_{t-1}| > \theta$,

Then

t is a rebalancing day, and

$K_t = thK_t$

Else

t is not a rebalancing day

$K_t = K_{t-1}$

where:

θ = Minimum Daily Allocation Change

K_t = the actual leverage factor on day *t*

Dynamic rebalancing can be combined with monthly rebalancing. In this case, besides intra-monthly rebalancing triggered by breach of Minimum Daily Allocation Change, the risk control index rebalances after the close of the last business day of the month.

Capped Equity Weight Change

For daily rebalanced or dynamic rebalanced risk control indices, some investors like to control for excessive position change. This feature is incorporated in the risk-control framework by introducing a Maximum Daily Allocation Change , $\bar{\theta}$.

The theoretical leverage factor is determined in the same way as in a Dynamic Rebalanced Risk Control Index. The trade decision is based on the difference between the theoretical leverage factor and the leverage factor on the last rebalancing date:

If $|thK_t - K_{t-1}| > \theta$,

Then:

t is a rebalancing day, and

$$K_t = \begin{cases} Min(K_{t-1} + \bar{\theta}, thK_t), & if\ thK_t - K_{t-1} > 0 \\ Max(K_{t-1} - \bar{\theta}, thK_t), & if\ thK_t - K_{t-1} \le 0 \end{cases}$$

Else

t is not a rebalancing day

$K_t = K_{t-1}$

where:

θ = Minimum Daily Allocation Change (θ >0 for dynamic rebalanced risk control indices, and $\theta = 0$ for daily rebalanced risk control indices).

$\bar{\theta}$ = Maximum Daily Allocation Change

K_t = the actual leverage factor on day t

Dynamic rebalancing can be combined with monthly rebalancing. In this case, besides intra-monthly rebalancing triggered by breach of Minimum Daily Allocation Change, the risk control index rebalances after the close of the last business day of the month.

Excess Return Indices

Asia Index Private Limited' Excess Return Indices are designed to track an unfunded investment in an underlying index. In other words, an excess return index calculates the return on an investment in an index where the investment was made through the use of borrowed funds. Thus, the return of an excess return index will be equal to that of the underlying index less the associated borrowing costs. Most Asia Index Private Limited calculate an excess return index level to mirror an unfunded position.

The formula for calculating the Excess Return Index is as follows:

$$ExcessReturn = \left(\frac{Underlying\ Index_t}{Underlying\ Index_{t-1}} - 1\right) - \left(\frac{Borrowing\ Rate}{360}\right) * D_{t,t-1} \quad (4)$$

The Excess Return Index Value at time *t* can be calculated as:

$$ExcessReturnIndexValue_t = (ExcessReturnIndexValue_{t-1}) * (1 + ExcessReturn) \quad (5)$$

Substituting (4) into (5) and expanding the right hand side of (5) yields:

$$ExcessReturnIndexValue_t =$$

$$ExcessReturn\ IndexValue_t =$$

$$ExcessReturn\ IndexValue_{t-1} * \left[1 + \left[\left(\frac{UnderlyingIndex_t}{UnderlyingIndex_{t-1}} - 1\right) - \left[\frac{Borrowing\ Rate}{360}\right] * D_{t,t-1}\right]\right]$$

where:

Borrowing Rate = The investment funds borrowing rates, which will differ for each excess return index[7]

$D_{t,\ t-1}$ = The number of calendar days between date *t* and *t-1*

[7] Generally, an overnight rate, such as SOFR overnight in the U.S. or ESTR in Europe, will be used. However, in some cases other interest rates may be used. A 365-day year is assumed for the interest calculations in accordance with Indian banking practices.

Exponentially-Weighted Volatility

The realized volatility is calculated as the maximum of two exponentially weighted moving averages, one measuring short-term and one measuring long-term volatility.

$$RealizedVolatility_t = Max\left(RealizedVolatility_{S,t}, RealizedVolatility_{L,t}\right)$$

where:

S,t = The short-term volatility measure at time *t*, calculated as:

(6)

$$RealizedVolatility_{S,t} = \sqrt{\frac{252}{n} * Variance_{S,t}}$$

for $t > T_0$

$$Variance_{S,t} = \lambda_S * Variance_{S,t-1} + (1-\lambda_S) * \left[\ln\left(\frac{UnderlyingIndex_t}{UnderlyingIndex_{t-n}}\right)\right]^2$$

for $t = T_0$

$$Variance_{S,T_0} = \sum_{i=m+1}^{T_0} \frac{\alpha_{S,i,m}}{WeightingFactor_S} * \left[\ln\left(\frac{UnderlyingIndex_i}{UnderlyingIndex_{i-n}}\right)\right]^2$$

L,t = The long-term volatility measure at time *t*, calculated as:

(7)

$$RealizedVolatility_{L,t} = \sqrt{\frac{252}{n} * Variance_{L,t}}$$

for $t > T_0$

$$Variance_{L,t} = \lambda_L * Variance_{L,t-1} + (1-\lambda_L) * \left[\ln\left(\frac{UnderlyingIndex_t}{UnderlyingIndex_{t-n}}\right)\right]^2$$

for $t = T_0$

$$Variance_{L,T_0} = \sum_{i=m+1}^{T_0} \frac{\alpha_{L,i,m}}{WeightingFactor_L} * \left[\ln\left(\frac{UnderlyingIndex_i}{UnderlyingIndex_{i-n}}\right)\right]^2$$

where:

T_0 = The start date for a given risk control index

n = the number of days inherent in the return calculation used for determining volatility[15]

m = the N^{th} trading date prior to T_0

N = the number of trading days observed for calculating the initial variance as of the start date of the index

λ_S = The short-term decay factor used for exponential weighting[16]

λ_L = The long-term decay factor used for exponential weighting[10]

$\alpha_{S,m,i}$ = Weight of date t in the short-term volatility calculation, as calculated based on the following formula:

$$\alpha_{S,t} = (1-\lambda_S) * \lambda_S^{N+m-i}$$

$$WeightingFactor_S = \sum_{i=m+1}^{T_0} \alpha_{S,i,m}$$

$\alpha_{L,m,i}$ = Weight of date t in the long-term volatility calculation, as calculated based on the following formula:

$$\alpha_{L,t} = (1-\lambda_L) * \lambda_L^{N+m-i}$$

$$WeightingFactor_L = \sum_{i=m+1}^{T_0} \alpha_{L,i,m}$$

The interest rate, maximum leverage, target volatility and the lambda decay factors are defined in relation to each index and are generally held constant throughout the life of the index. The leverage position changes at each rebalancing based on changes in realized volatility. There is a two-day lag between the calculation of the leverage factor, based on the ratio of target volatility to realized volatility, and the implementation of that leverage factor in the index.

The above formulae can be used for simpler models by the appropriate choice of parameters. For example, if the short-term and long-term decay factors, λ_S and λ_L are set to the same value (e.g., 5%) than there are no separate considerations for short-term and long-term volatility.

Exponentially-Weighted Volatility Based on Current Allocations

The index calculations are the same as described in the Exponentially Weighted Volatility section above, except that realized volatility is calculated using the returns derived from the levels of hypothetical underlying index based on the current allocations within the underlying index and historical returns of those constituents, rather than the historical levels of the underlying index.

Underlying Index$_t$ = Hypothetical underlying index level on day *t*, calculated as

$$Underlying\ Index_t = Underlying\ Index_{t-1} * (1 + \sum_{i=i}^{K} w_i * r_{i,t})$$

where:

K = number of constituents in current underlying index as of day t $r_{i,t}$ = return of the *i*-th constituent in the underlying index on day *t*

w_i = weight of the *i*-th constituent in current underlying index

Simple-Weighted Volatility

The realized volatility is calculated as the maximum of two simple-weighted moving averages, one measuring short-term volatility and one measuring long-term volatility.

$$RealizedVolatility_t = Max(RealizedVolatility_{S,t}, RealizedVolatility_{L,t})$$

where:

S,t = The short-term volatility measure at time *t*, calculated as:

$$RealizedVolatility_{S,t} = \sqrt{\frac{252}{n} * Variance_{S,t}}$$

$$Variance_{S,t} = 1/N_S * \sum_{i=t-Ns+1}^{t} \ln\left(\frac{UnderlyingIndex_i}{UnderlyingIndex_{i-n}}\right)^2$$

L,t = The long-term volatility measure at time *t*, calculated as:

$$RealizedVolatility_{L,t} = \sqrt{\frac{252}{n} * Variance_{L,t}}$$

$$Variance_{L,t} = 1/N_L * \sum_{i=t-Nl+1}^{t} \ln\left(\frac{UnderlyingIndex_i}{UnderlyingIndex_{i-n}}\right)^2$$

where:

n = The number of days inherent in the return calculation used for determining volatility[8]

N_S = The number of trading days observed for calculating variance for the short-term volatility measure

N_L = The number of trading days observed for calculating variance for the long-term volatility measure

Underlying Index$_t$ is defined as in the "Exponentially-Weighted Average Volatility" section.

[8] If *n* = 1 daily returns are used, while if *n* = 2 two day returns are used, and so forth.

Futures-Based Risk Control Indices

When the underlying index is based on futures contracts, most of the Risk Control methodology follows the details on the prior six pages. However, there are some differences as detailed below, particularly as it relates to the cash component of the index.

For such an index, it includes a leverage factor that changes based on realized historical volatility. If realized volatility exceeds the target level of volatility, the leverage factor will be less than one; if realized volatility is lower than the target level, the leverage factor may be greater than one. A given risk control index may have a maximum leverage factor that cannot be exceeded.

For equity risk control indices, the return consists of two components: (1) the return on the position in the underlying Asia Index Private Limited index and (2) the interest cost or gain, depending upon whether the position is leveraged or deleveraged. For futures-based risk control indices, there is no borrowing or lending to achieve investment objectives in the underlying index. Therefore, the cash component of the Index does not exist.

Again, a leverage factor greater than one represents a leveraged position, a leverage factor equal to one represents an unleveraged position, and a leverage factor less than one represents a deleveraged position. The leverage factor may change at regular intervals, in response to changes in realized historical volatility, or when the expected volatility exceeds or falls below predetermined volatility thresholds, if such thresholds were in place.

The formula for calculating the Risk Control Excess Return Index largely follows that detailed beginning with equation (1). However, since there is no funding for such indices (as opposed to the case with equity excess return indices, where the initial investment is presumedly borrowed, and excess cash is, likewise, assumed to be invested), the interest rate used in the calculation is eliminated:

$$Risk\ Control\ Excess\ Return\ Index\ Return_t = K_{rb} * \left(\frac{Underlying\ Index_t}{Underlying\ Index_{rb}} - 1 \right) \tag{8}$$

The Risk Control Excess Return Index Value at time *t* can, then, be calculated as:

$$RiskControlExcessReturnIndexValue_t =$$
$$(RiskControlExcessReturnIndex\ Value_{rb}) * (1 + RiskControlExcessReturnIndex\ Return_t)$$

The formula for calculating the Risk Control Total Return Index, which includes interest earned on Treasury Bills, is as follows:

$$Risk\ Control\ Total\ Return\ Index\ Return_t =$$
$$K_{rb} * \left(\frac{Underlying\ Index_t}{Underlying\ Index_{rb}} - 1 \right) + \left[\prod_{i=rb+1}^{t} (1 + InterestRate_{i-1} * D_{i-1,i} / 360) - 1 \right] \tag{9}$$

The Risk Control Total Return Index Value at time *t* can, then, be calculated as:

$$RiskControlTotalReturnIndexValue_t = \tag{10}$$
$$(RiskControlTotalReturnIndexValue_{rb}) * (1 + RiskControlTotalReturnIndex\ Return_t)$$

Substituting equation (9) into (10) and expanding yields:

Risk Control Total Return Index Value$_t$ =

$$RiskControlTotalReturnIndexValue_t = (RiskControlTotalReturnIndex\ Value_{rb}) * (1 + RiskControlTotalReturnIndex\ Return_t) \quad (10)$$

where all variables in equations (8)-(11) are the same as those defined for (1)-(3) except:

Interest Rate$_{i-1}$ = The interest rate set for the index

Exponentially-Weighted Volatility for Futures-Based Risk Control Indices

Please refer to the *Risk Control 2.0 Indices* section of this document for information on Exponentially-Weighted Volatility. However, for futures-based risk control indices there is a three (3)-day lag between the calculation of the leverage factor, based on the ratio of target volatility to realized volatility, and the implementation of that leverage factor in the index.

Dynamic Volatility Risk Control Indices

In dynamic volatility risk control indices, the volatility target is not set as a definition of the index. Rather it is set at various levels based on the moving average of VIX computed over a predetermined number of days (e.g., 30-day moving average).

Variance Based Risk Control Indices

In variance-based risk control indices, a target level of variance is set rather than a target volatility level. This allows for faster leveraging or deleveraging of allocations based on changes in volatility or variance in the market. For these indices:

$$K_{rb} = Min(Max\ K, Target\ Variance/Realized\ Variance_{rb-d})$$

where variance is defined as per above.
All other index calculations remain the same.

Weighted Return Indices

Asia Index Private Limited's Weighted Return Indices combine the returns of two or more underlying indices using a specified set of weighting rules to create a new unique index return series. An index that uses the Weighted Return methodology might also be referred to as an "Index of Indices." Weighted Return indices may include a cash component which for the purposes of these indices is treated as an underlying index. Asia Index Private Limited offers both daily and periodic rebalance approaches for weighted return indices.

Based on the specification in the individual index methodologies, weighted return indices will be calculated using one of the below formulas:

Daily Rebalancing:

$$Index_t = Index_{t-1} \times \left(1 + \sum_{i=1}^{N} \left(weight_{i,t} \times \left(\frac{ComponentIndex_{i,t}}{ComponentIndex_{i,t-1}} - 1\right)\right) + CashWeight_t \times InterestReturn_t\right)$$

Periodic Rebalancing, accruing interest:

$$Index_t = Index_r \times \left(1 + \sum_{i=1}^{N} \left(weight_{i,r} \times \left(\frac{ComponentIndex_{i,t}}{ComponentIndex_{i,r}} - 1\right)\right) + CashWeight_r \times \left(\prod_{d=r+1}^{t} (1 + InterestReturn_d) - 1\right)\right)$$

Interest Return Options:

$$InterestReturn_t = \begin{cases} \frac{InterestRate_{t-1}}{AccountingDays} \times ACT(t, t-1), for\ simple\ daily\ accrual \\ \left(\left(1 + \frac{InterestRate_{t-1}}{AccountingDays}\right)^{ACT(t,t-1)} - 1\right), for\ accrual\ compounding\ over\ an\ index\ noncalc\ day \\ \left(\frac{1}{\left(1 - \frac{91}{AccountingDays} \times RiskFree\ Rate_{t-1}\right)}\right)^{\frac{ACT(t,t-1)}{91}} - 1, for\ 3\ month\ RiskFree\ Rate\ accrual \end{cases}$$

where:

$Index_t$	= the value of the top level index on day *t*
$Index_r$	= the value of the top level index at the previous rebalancing date *r*[19]
$weight_{i,t}$	= the weight of component index *i* on day *t*
$weight_{i,r}$	= the weight of component index *i* on the previous rebalancing date *r*
$ComponentIndex_{i,t}$	= the value of the component index *i* on day *t*
$ComponentIndex_{i,r}$	= the value of the component index *i* on the previous rebalancing date *r*[20]
N	= the number of component indices within the top level index
$CashWeight_t$	= the weight of the cash component on day *t*
$CashWeight_r$	= the weight of the cash component on the previous rebalancing date *r*
$InterestReturn_t$	= the return from the interest rate (see *Interest Return Options* above)

19 Note that the value is as of the close of the rebalancing date.
20 Note that the value is as of the close of the previous rebalancing date.

InterestReturn$_{t-1}$ = the interest rate from the previous calculation date *t -1*[21]

Accounting Days = the day count convention for *InterestRate*$_{t-1}$. Days counts are typically 252, 360, or 365.

ACT(t, t - 1) = the calendar day between calculation day *t -1* and calculation day *t*, expressed as the day (*t*) – (*t* – *1*).

RiskFree Rate$_{t-1}$ = S&P DJI typically uses the three-month (3M) T-Bill rate published weekly by *treasurydirect.gov*.

Component Indices Weightings and Returns:

Daily Rebalancing:

$$Weight_{\,i,t} = \frac{ADJ\ Weight_{i,t-1} * (1 + Daily\ Return_{i,t})}{(1 + Index\ Return_t)}$$

$$Daily\ Return_{\,i,t} = \frac{Component\ Index_{\,i,t}}{Component\ Index_{\,i,t-1}} - 1$$

$$Index\ Return_{\,t} = \frac{Index_{\,t}}{Index_{\,t-1}} - 1$$

Periodic Rebalancing, accruing interest:

$$Weight_{\,i,t} = \frac{ADJ\ Weight_{i,r} * (1 + Daily\ Return_{i,t})}{(1 + Index\ Return_t)}$$

$$Daily\ Return_{\,i,t} = \frac{Component\ Index_{\,i,t}}{Component\ Index_{\,i,r}} - 1$$

$$Index\ Return_{\,t} = \frac{Index_{\,t}}{Index_{\,r}} - 1$$

where:

Weight $_{i,t}$ = the weight of component index *i* on day *t*

ADJ Weight $_{i,t-1}$ = the Adjusted close weight of component index *i* on day *t-1*

N = the number of component indices within the top-level index

Daily Return $_{i,t}$ = daily return of component index *i* on day

Index Return$_t$ = the return of the weighted return index on day *t*.

Capped Return Indices

In a capped return index, the index return from the prior rebalancing is capped at a pre-defined level. The overall approach is to first calculate an uncapped index and then compare its return-since-last rebalancing-day with the return cap. The capped index return takes the smaller value of these two. The approach can be expressed mathematically as:

$$Index\ Level_t = Index\ Level_{LR} * (1 + \min\left(ReturnCap, \frac{Uncapped\ Index\ Level_t}{Uncapped\ Index\ Level_{LR}}\right))$$

where:

index level$_t$ = Index level at date *t*

index level$_{LR}$ = Index level at the last rebalancing business day

ReturnCap = Cap on the index return between rebalance dates

Alternative Pricing

AIPL's Indices uses alternative pricing for the calculation and publication of certain indices and data points. Alternative pricing is applied to indices using the approaches outlined below. Details of the pricing type and application of the pricing for index calculation purposes is indicated in the specific index methodology.

1. Official Calculation: The daily official index calculation always leverages the alternative price methodology.
2. Hybrid Calculation: The alternative price is used in certain instances when calculating the official index value (e.g., VWAP pricing used for official daily index calculation on the rebalance implementation while the official close is used for all non-rebalance date calculations)
3. Supplementary Calculation: A supplementary calculation of the index is performed with the alternative price and is published alongside the official closing calculation (e.g., Special Open Quotation).

Alternative pricing may be captured through vendors or calculated internally by AIPL. The formulae defined in this section are specific to internally calculated alternative pricing. This approach is more commonly applied to derivative based indices calculated by AIPL. AIPL leverages BSE provided prices for official end-of-day index calculations. AIPL will use the relevant price (e.g. last trade, auction, VWAP, official close).

Special Opening Quotation (SOQ)

The special opening quotation ("SOQ") is calculated using the same methodology as the underlying index except that the price used for each index constituent is the open price at which the security first trades upon the opening of the exchange on a given trading day. SOQ is calculated using only the opening prices from the primary exchange, which occur at various times, of all stocks in the index and may occur at any point during the day. For any stock that has not traded during the regular trading session, the previous day's closing price is used for the SOQ index calculation. SOQ may be higher than the high, lower than the low and different from the open, as the SOQ is a special calculation with a specific set of parameters. The open, high, low and close values are continuous calculations, while the SOQ waits until all stocks in the index are open.

- In the case of a market disruption and if the exchange is unable to provide official opening prices, the official closing prices are utilized. If the exchange is unable to provide official opening or closing prices, the previous closing price adjusted for corporate actions is used in the calculation of the SOQ.

For M&A target stocks that are suspended or halted from trading on an exchange but are still in indices, Asia Index Private Limited will synthetically derive an SOQ for the suspended security using the deal ratio terms and the opening price of the acquiring company if the acquirer is issuing stock as part of the merger. If the acquirer is paying cash only, the lower of the previous official close price and the cash amount are used in the calculation of the SOQ. Similarly, AIPL will synthetically derive an SOQ for spun-off stocks that have not yet begun trading.

Volume-Weighted Average Price (VWAP)

Volume Weighted Pricing uses a weighted average price instead of a single closing value. Prices with bigger trading volumes are assigned higher weights. VWAP is calculated by multiplying the price of trades by their volume, summing that for the applicable time window, and then dividing by the total volume of trades within that time window, as calculated below:

$$VWAP_{i,t} = \frac{\sum_{j=1}^{N} TradeVolume_{i,j} \times TradePrice_{i,j}}{\sum_{j=1}^{N} TradeVolume_{i,j}}$$

where:

$VWAP_{i,t}$	= the VWAP for security *i* on day *t* over the VWAP observation window
N	= the number of trades in the VWAP observation window
$TradeVolume_{i,j}$	= the volume of trade *j*
$TradePrice_{i,j}$	= the price of trade *j*

Index Turnover

Index turnover is a measure of weight changes to an index resulting from corporate events or rebalancing of an index. Weight changes resulting from market value changes due to market driven price increases or decreases are not accounted for in an index turnover calculation. All turnover figures provided by Asia Index Private Limited are one-way turnover figures. One-way turnover only views turnover from the perspective of either buying or selling assets. One-way turnover is therefore limited to a maximum amount of 100% which would be equivalent to the deletion of all current index constituents or the addition of all new constituents. To differentiate between a one-way and two-way turnover approach, a two-way turnover approach would reflect both the buying and selling of assets. Two-way index turnover would be
200% in the above scenario. A formula of index turnover is provided below. All turnover calculations are provided by Asia Index Private Limited upon request.

$$Index\ Turnover = \frac{\sum_i Constituent\ Weight\ Change}{2}$$

$$Constituent\ Weight\ Change = |Constituent\ Weight\ CLS - Constituent\ Weight\ ADJ|$$

where:

Constituent Weight CLS = Weight of constituent as of the close of business on day T.

Constituent Weight ADJ = Weight of constituent prior to the open on day T+1. This weight will reflect any adjustments due to corporate events or rebalancing. If the index had no corporate events or rebalancing, the Constituent Weight CLS will be equal to Constituent Weight ADJ.

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Fundamental Data Points

Underlying data point values used for fundamental index level ratio calculations are described below:[9]

1. **Basic EPS − Continuing Operations (FY0).** This is a given company's basic earnings-per-share excluding extra items for the latest reported fiscal year and is calculated as:

   Basic EPS – Continuing Operations (FY0) = (Net Income − Preferred Dividend and Other Adjustments − Earnings of Discontinued Operations − Extraordinary Item & Accounting Change) / Weighted Average Basic Shares Outstanding

2. **Basic Weighted Average Shares Outstanding (FY0).** This is a given company's basic weighted average shares outstanding for the latest reported fiscal year.

3. **Estimate EPS (FY1).** This is a given company's one year forward estimated earnings-per-share and represents the aggregated mean of all latest reported fiscal year plus one year estimates provided by third-party vendor analysts.

4. **Estimate EPS (FY2).** This is a given company's two year forward estimated earnings-per-share and represents the aggregated mean of all latest reported fiscal year plus two year estimates provided by third-party vendor analysts.

5. **Basic EPS − Continuing Operations (LTM).** This is a given company's basic earnings-per share excluding extra items over the last 12 months and is calculated as:

   Basic EPS – Continuing Operations (LTM) = (Net Income − Preferred Dividend and Other Adjustments − Earnings of Discontinued Operations − Extraordinary Item & Accounting Change) / Weighted Average Basic Shares Outstanding

6. **Basic Weighted Average Shares Outstanding (LTM).** This is a given company's basic weighted average shares outstanding over the last 12 months.

7. **Total Common Equity (FY0).** This is a given company's total common equity for the latest reported fiscal year and is calculated as:

   Total Common Equity (FY0) = Common Stock & APIC + Retained Earnings + Treasury Stock & Other.

8. **Cash from Operations (FY0).** This is the given company's cash from operations for the latest reported fiscal year and is calculated as:

   Cash from Operations (FY0) = Net Income + Depreciation and Amortization, Total + Amortization of Deferred Charges, Total − (CF) + Other Non-Cash Items, Total + Change in Net Operating Assets

9. **Total Revenue (FY0).** This is the given company's total revenue for the latest reported fiscal year and is calculated as:

   Total Revenue (FY0) = Revenue + Other Revenue

10. **Shares Outstanding.** This is the given company's shares outstanding and provides total company level shares, as reported by stock exchanges, company press releases, and financial documents. Treasury shares are excluded, and the number is adjusted for corporate actions such as splits, merger related share issuances, rights offerings, etc.

11. **Indicated Annualized Dividend.** This is the given company's latest annualized dividend per share. It is a forward looking number and is calculated by multiplying the latest dividend paid per share by the number of dividend payments per year.

[9] All stocks with ADRs are adjusted per the depository receipt ratio except for EPS and Dividend data points.

Calculations

Monthly calculation of the fundamental data for a given index is done as of the last calendar day of the month.[10]

Terminology. Various terms are used in the calculations below and are defined as follows:

- **AWF.** The Additional Weight Factor (AWF) is the adjustment factor of a stock assigned at each index rebalancing date which adjusts the market capitalization for all index constituents to achieve the user-defined weight, while maintaining the total market value of the overall index.
- **IWF.** A stock's Investable Weight Factor (IWF) is based on its free float. Free float can be defined as the percentage of each company's shares that are freely available for trading in the market. For further details, please refer to *Asia Index Private Limited' Float Adjustment Methodology*.
- **SO.** The shares outstanding of a company.

Index Level Ratios. The formulas below are used to calculate index level ratios:[11]

1. Price to Earnings Ratio:

Index Market Capitalisation / Adjusted Earnings

Note: Index market capitalization of the Index constituents is the sum total of the outstanding equity shares considered for index computation multiplied by the close price of index constituent. Market Capitalisation is adjusted for factors such as free-float, capping factor etc. based on the index methodology; and the consolidated earnings (including profits and losses) reported by each index constituent in trailing 4 quarters are cumulated and adjusted for factors such as free-float, capping factor etc. depending upon the index methodology to arrive at the adjusted earnings. Wherever, consolidated financials are not available, standalone financials for trailing 4 quarters are considered.

2. Price to Book Value:

Index Market Capitalisation / Book Value or Net-worth

Note: Index market capitalization of the Index constituents is the sum total of the outstanding equity shares considered for index computation multiplied by the latest close price of index constituent. Market Capitalisation is adjusted for factors such as free-float, capping factor etc. based on the index methodology. The equity capital and the reserves & surplus (networth) reported by each index constituent in the standalone annual financial report are cumulated and adjusted for factors such as free-float, capping factor etc. depending upon the index methodology to arrive at the book-value

3. Dividend Yield:

Gross Dividend / Index Market Capitalisation * 100

Note: Dividend yield is represented in percentage terms. The equity dividends consisting of interim, final dividend etc. reported by each Index constituent on rolling 12 months basis are cumulated and adjusted for factors such as free-float, capping factor etc. based on the Index Methodology to arrive at Gross Dividend. These are calculated based on ex-dividend date. Index market capitalization of the Index constituents is the sum total of the outstanding equity shares considered for index computation multiplied by the latest close price of index constituent. Market Capitalisation is adjusted for factors such as free-float, capping factor etc. based on the index methodology.

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[10] The calculation of fundamental ratios is done based on the index's current composition as of the date of the fundamental ratio calculation.

Asia Index Private Limited's Contact Information

Client Services

BSEINDEX@bseindia.com

Disclaimer

Performance Disclosure/Back-Tested Data

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Please refer to the methodology for the Index for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Information presented prior to an index’s launch date is hypothetical back-tested performance, not actual performance, and is based on the index methodology in effect on the launch date. However, when creating back-tested history for periods of market anomalies or other periods that do not reflect the general current market environment, index methodology rules may be relaxed to capture a large enough universe of securities to simulate the target market the index is designed to measure or strategy the index is designed to capture. For example, market capitalization and liquidity thresholds may be reduced. Back-tested performance reflects application of an index methodology and selection of index constituents with the benefit of hindsight and knowledge of factors that may have positively affected its performance, cannot account for all financial risk that may affect results and may be considered to reflect survivor/look ahead bias. Actual returns may differ significantly from, and be lower than, back-tested returns. Past performance is not an indication or guarantee of future results.

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