Scientific Beta
An EDHEC-Risk Institute Venture

ERI Scientific Beta Index Calculation Rules

2017, July

Table of contents

Introduction

This document describes the methodology for the calculation of Scientific Beta Equity Indices. It provides an overview of their calculation process as well as the detailed calculation formulas together with the adjustments made due to regular changes in constituents and corporate actions.

Scientific Beta Equity Indices are calculated in local currency as well as in USD. For indices containing stocks from different countries, the local currency is set to be USD. Index levels are also available in three other main currencies: GBP, EUR, and JPY.

Scientific Beta Equity Indices are calculated end-of-day, five days a week, from Monday to Friday.

Scientific Beta Cap-Weighted Indices are adjusted for free-float, which is the percentage of total shares outstanding available for investors to trade. Free-float adjustment is described in more detail in ERI Scientific Beta Universe Construction Rules. Unless stated otherwise, the number of shares outstanding used in the calculation of Scientific Beta Equity Indices is adjusted for free-float.

Additional documents about the construction methodology and the universe construction of the Scientific Beta Equity Indices series can be found at www.scientificbeta.com.

Price Index Methodology

The Price Index aggregates the price changes of its constituents. In principle, ERI Scientific Beta calculates the current index level calculated on the basis of the previous trading day index level, taking into consideration adjustments for corporate actions.

1.1. Capitalisation Weighted Indices

The price index level is calculated by applying the change in free-float adjusted market capitalisation to the index level at the previous time period.

1.1.1. Capitalisation Weighted Index Formula

$$PI_t = PI_{t-1} \frac{\text{Index Closing Market Value}_t}{\text{Index Initial Market Value}_t}$$

$$= PI_{t-1} \frac{\sum_k (n_{k,t}\, p_{k,t}\, x_{k,t})}{\sum_k (n_{k,t-1}\, p_{k,t-1}\, x_{k,t-1})}$$

where:
PI_t is the price index at time t
PI_{t-1} is the price index level at time t-1
$n_{k,t}$ is the number of shares outstanding of stock k at time t
$p_{k,t}$ is the closing price of stock k at time t
$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t
$n_{k,t-1}$ is the number of shares outstanding of stock k at time t-1
$p_{k,t-1}$ is the closing price of stock k at time t-1
$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1

The index initial market value at time t is calculated as the index closing market value at time t-1. The ratio of the index closing market value at time t over the index initial market value at time t represents the change in the market capitalisation.

1.1.2. Adjustments for Corporate Actions

To maintain an index, adjustments to corporate actions need to be made so that the changes due to corporate actions do not affect the index level. For example, when stocks are swapped into and out of an index, though the market value of the index would usually change, the index level should not move up or down. Without adjustment for corporate actions, the index initial market value at time t is calculated as the index closing market value at time t-1.

Let ΔMVC_{t-1} be the difference between the adjusted index initial market value at time t and the index closing market value at time t-1, the formula after adjustments for corporate actions is therefore modified as:

$$PI_t = PI_{t-1} \frac{\text{Index Closing Market Value }_t}{\text{Adjusted Index Initial Market Value }_t}$$

$$= PI_{t-1} \frac{\text{Index Closing Market Value }_t}{\text{Index Closing Market Value }_{t-1} + \Delta MVC_{t-1}}$$

In practice, ΔMVC_{t-1} is calculated at the stock level (defined as $C_{k,t-1}$ in the below equation) and then integrated into the closing market value at time t-1 to derive the adjusted index initial market value at time t as follows:

$$PI_t = PI_{t-1} \frac{\sum_k (n_{k,t}\, p_{k,t}\, x_{k,t})}{\sum_k (n_{k,t-1}\, p_{k,t-1}\, x_{k,t-1} + C_{k,t-1})}$$

$$= PI_{t-1} \frac{\sum_k (n_{k,t}\, p_{k,t}\, x_{k,t})}{\sum_k (n_{k,t}\, p^*_{k,t}\, x_{k,t-1})}$$

where:
PI_t is the price index at time t
PI_{t-1} is the price index level at time t-1
$n_{k,t}$ is the number of shares outstanding of stock k at time t
$p_{k,t}$ is the closing price of stock k at time t
$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t
$n_{k,t-1}$ is the number of shares outstanding of stock k at time t-1
$p_{k,t-1}$ is the closing price of stock k at time t-1
$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1
$C_{k,t-1}$ is the adjustment to market value due to corporate action for stock k at time t-1
$p^*_{k,t}$ is the adjusted price of stock k

The adjusted index initial market value at time t is expressed as the product of adjusted stock price $p^*_{k,t}$ and the number of shares outstanding at time t $n_{k,t}$. The detailed calculation for the market value change $C_{k,t-1}$ and the adjusted stock price $p^*_{k,t}$ can be found in Section 6 "Adjustments for Corporate Actions".

1.1.3. Constituent's Market Cap Weight

The constituent's Market Cap weight is calculated as:

$$w_{k,t} = \frac{n_{k,t} p_{k,t} x_{k,t}}{\sum_k (n_{k,t} p_{k,t} x_{k,t})}$$

The weights also need to be adjusted for a set of corporate actions (as listed in Section 6 "Adjustments for Corporate Actions":

$$w^*_{k,t} = \frac{n_{k,t} p^*_{k,t} x_{k,t-1}}{\sum_k (n_{k,t} p^*_{k,t} x_{k,t-1})}$$

The adjusted index formula can also be presented using the constituent's adjusted weight:

$$PI_t = PI_{t-1} \frac{\text{Index Closing Market Value}_t}{\text{Adjusted Index Initial Market Value}_t}$$

$$= PI_{t-1} \frac{\sum_k (n_{k,t}\, p_{k,t}\, x_{k,t})}{\sum_k (n_{k,t}\, p^*_{k,t}\, x_{k,t-1})}$$

$$= PI_{t-1} \sum_k \left(\frac{n_{k,t} p^*_{k,t} x_{k,t-1}}{\sum_k (n_k p^*_k x_{k,t-1})} \right) \frac{p_{k,t} x_{k.t}}{p^*_k x_{k,t-1}}$$

$$= PI_{t-1} \sum_k (w^*_{k,t} \frac{p_{k.t} x_{k,t}}{p^*_{k,t} x_{k,t-1}})$$

As stock prices change during the trading day, the stock weights will change accordingly. The relationship between weight change and the ratio of the price index level can be expressed as follows:

$$\frac{w_{k,t}}{w^*_{k,t}} = \frac{n_{k,t} p_{k,t} x_{k,t}}{\sum_k (n_{k,t} p_{k,t} x_{k,t})} \cdot \frac{\sum_k (n_{k,t} p^*_{k.t} x_{k,t-1})}{n_{k,t} p^*_{k,t} x_{k,t-1}} = \frac{p_{k,t} x_{k,t}}{p^*_{k,t} x_{k,t-1}} \cdot \frac{\sum_k (n_{k,t} p^*_{k.t} x_{k,t-1})}{\sum_k (n_{k,t} p_{k,t} x_{k,t})} = \frac{p_{k.t} x_{k,t}}{p^*_{k,t} x_{k,t-1}} \cdot \frac{PI_{t-1}}{PI_t}$$

where:
PI_t is the price index at time t
PI_{t-1} is the price index level at time t-1
$n_{k,t}$ is the number of shares outstanding of stock k at time t
$p_{k,t}$ is the closing price of stock k at time t
$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t
$n_{k,t-1}$ is the number of shares outstanding of stock k at time t-1
$p_{k,t-1}$ is the closing price of stock k at time t-1
$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1
$p^*_{k,t}$ is the adjusted price of stock k
$w^*_{k,t}$ is the adjusted market cap weight of stock k at time t
$w_{k,t}$ is the market cap weight of stock k at time t

1.2. Alternative Weighted Indices

Alternative weighted indices are constructed according to other criteria than market capitalisation. As stock prices change, constituents'weights may shift from alternative target weights and the indices need to be rebalanced to re-establish target weights. By contrast, cap-weighted indices require no rebalancing as long as there is no addition/deletion of stocks or corporate actions affecting their composition.

ERI Scientific Beta Equity Indices are reviewed quarterly on the close of the third Fridays of March, June, September and December.

1.2.1. Alternative Weighted Index Formula

We recall the cap-weighted index formula:

$$\mathrm{PI_t} = \mathrm{PI_{t-1}} \frac{\text{Index Closing Market Value }_{\mathrm{t}}}{\text{Index Initial Market Value }_{\mathrm{t}}} = \mathrm{PI_{t-1}} \frac{\sum_{\mathrm{k}}(\mathrm{n_{k,t}\ p_{k,t}\ x_{k,t}})}{\sum_{\mathrm{k}}(\mathrm{n_{k,t-1}\ p_{k,t-1}\ x_{k,t-1}})}$$

In the case of alternative indices, the number of shares outstanding $n_{k.t}$ in the basic formula is therefore modified to target share count $q_{k,t}$ as follows:

$$\mathrm{PI_t} = \mathrm{PI_{t-1}} \frac{\sum_{\mathrm{k}}(\mathrm{q_{k,t}\ p_{k,t}\ x_{k,t}})}{\sum_{\mathrm{k}}(\mathrm{q_{k,t-1}\ p_{k,t-1}\ x_{k,t-1}})}$$

We note that the market value of the alternative index portfolio stays the same before and after the rebalancing at time t and the price index level at time t:

$$\text{Index Closing Market Value }_{\text{before rebalancing}} = \sum_{\mathrm{k}} (\mathrm{q_{t,k\ before\ rebalancing} p_{k,t}\ x_{k,t}})$$

$$= \text{Index Closing Market Value }_{\text{after rebalancing}} = \sum_{\mathrm{k}} (\mathrm{q_{t,k\ after\ rebalancing} p_{k,t}\ x_{k,t}})$$

where:
$\mathrm{PI_t}$ is the price index at time t
$\mathrm{PI_{t-1}}$ is the price index level at time t-1
$\mathrm{q_{k,t}}$ is the free float adjusted target share count of stock k at time t
$\mathrm{p_{k,t}}$ is the closing price of stock k at time t
$\mathrm{x_{k,t}}$ is the exchange rate from local currency into index currency for stock k at time t
$\mathrm{q_{k,t-1}}$ is the free float adjusted target share count of stock k at time t-1
$\mathrm{p_{k,t-1}}$ is the closing price of stock k at time t-1
$\mathrm{x_{k,t-1}}$ is the exchange rate from local currency into index currency for stock k at time t-1

1.2.2. Adjustments for Corporate Actions

The adjustments alternative weighted indices for corporate actions are the same than for the cap-weighted indices.

$$\mathrm{PI_t} = \mathrm{PI_{t-1}} \frac{\text{Index Closing Market Value }_{\mathrm{t}}}{\text{Adjusted Index Initial Market Value }_{\mathrm{t}}}$$

$$= \mathrm{PI_{t-1}} \frac{\sum_{\mathrm{k}}(\mathrm{q_{k,t}\ p_{k,t}\ x_{k,t}})}{\sum_{\mathrm{k}}(\mathrm{q_{k,t}\ p^{*}_{k,t}\ x_{k,t-1}})}$$

where:
$\mathrm{PI_t}$ is the price index at time t
$\mathrm{PI_{t-1}}$ is the price index level at time t-1
$\mathrm{q_{k,t}}$ is the free float adjusted target share count of stock k at time t
$\mathrm{p_{k,t}}$ is the closing price of stock k at time t
$\mathrm{x_{k,t}}$ is the exchange rate from local currency into index currency for stock k at time t
$\mathrm{q_{k,t-1}}$ is the free float adjusted target share count of stock k at time t-1
$\mathrm{p_{k,t-1}}$ is the closing price of stock k at time t-1
$\mathrm{x_{k,t-1}}$ is the exchange rate from local currency into index currency for stock k at time t-1
$\mathrm{p^{*}_{k,t}}$ is the adjusted price of stock k

The adjusted index initial value at time t due to corporate actions is expressed as the product of the adjusted stock price $p^{*}_{k,t}$ and the target share count at time t $q_{k,t}$, where the adjusted stock price $p^{*}_{k,t}$ is calculated the same way as in Section 2.1.3 for cap-weighted indices.

1.2.3. Constituent's Weight

The basic constituent's weight of alternative weighted indices is calculated in the same way as for cap-weighted indices. The target weights will be applied at each review. The weights will then evolve based on stock price move between two reviews:

$$w_{k,t} = \frac{q_{k,t}p_{k,t}x_{k,t}}{\sum_k(q_{k,t}p_{k,t}x_{k,t})}$$

The weights also need to be adjusted for corporate actions:

$$w^*_{k,t} = \frac{q_{k,t}p^*_{k,t}x_{k,t-1}}{\sum_k(q_{k,t}p^*_{k,t}x_{k,t-1})}$$

The adjusted index formula can also be presented using adjusted constituent's weight:

$$PI_t = PI_{t-1}\frac{\text{Index Closing Market Value}_t}{\text{Adjusted Index Initial Market Value}_t}$$

$$= PI_{t-1}\frac{\sum_k(q_{k,t}p_{k,t}x_{k,t})}{\sum_k(q_{k,t}p^*_{k,t}x_{k,t-1})}$$

$$= PI_{t-1}\sum_k\left(\frac{q_{k,t}p^*_{k,t}x_{k,t-1}}{\sum_k(q_{k,t}p^*_{k,t}x_{k,t-1})}\right)\frac{p_{k,t}x_{k.t}}{p^*_k x_{k,t-1}}$$

$$= PI_{t-1}\sum_k(w^*_k\frac{p_{k,t}x_{k.t}}{p^*_k x_{k,t-1}})$$

$$\frac{w_{k,t}}{w^*_{k,t}} = \frac{q_{k,t}p_{k,t}x_{k,t}}{\sum_k(q_{k,t}p_{k,t}x_{k,t})}\cdot\frac{\sum_k(q_{k,t}p^*_{k.t}x_{k,t-1})}{q_{k,t}p^*_{k,t}x_{k,t-1}} = \frac{p_{k,t}x_{k,t}}{p^*_{k,t}x_{k,t-1}}\cdot\frac{\sum_k(q_{k,t}p^*_{k.t}x_{k,t-1})}{\sum_k(q_{k,t}p_{k,t}x_{k,t})} = \frac{p_{k.t}x_{k,t}}{p^*_{k,t}x_{k,t-1}}\cdot\frac{PI_{t-1}}{PI_t}$$

where:
PI_t is the price index at time t
PI_{t-1} is the price index level at time t-1
$q_{k,t}$ is the free float adjusted target share count of stock k at time t
$p_{k,t}$ is the closing price of stock k at time t
$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t
$q_{k,t-1}$ is the free float adjusted target share count of stock k at time t-1
$p_{k,t-1}$ is the closing price of stock k at time t-1
$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1
$p^*_{k,t}$ is the adjusted price of stock k
$w^*_{k,t}$ is the adjusted weight of stock k at time t; it is the target weight at each rebalancing
$w_{k,t}$ is the weight of stock k at time t

Total Return Index

By contrast with price indices that are calculated without considering cash dividends, total return indices measure the overall market performance of an index, including price appreciation and income from regular cash dividend payments. The cash dividend is reinvested in the index on the ex-dividend date of the distribution, and contributes to the total return index performance.

Index formula

The index formula is based on adjusted price $p^*_{k,t}$ that takes corporate actions into account:

Cap-weighted indices

$$RI_t = RI_{t-1} \cdot \frac{\sum_k \left(n_{k,t} p_{k,t} x_{k,t} + n_{k,t} p^*_{k,t} x_{k,t-1} y_{k,t}\right)}{\sum_k n_{k,t} p^*_{k,t} x_{k,t-1}}$$

Alternative weighted indices

$$RI_t = RI_{t-1} \cdot \frac{\sum_k \left(q_{k,t} p_{k,t} x_{k,t} + q_{k,t} p^*_{k,t} x_{k,t-1} y_{k,t}\right)}{\sum_k q_{k,t} p^*_{k,t} x_{k,t-1}}$$

The index formula can also be presented using the constituent's adjusted weight:

Cap-weighted indices

$$RI_t = RI_{t-1} \cdot \sum_k \left(\frac{n_{k,t} p^*_{k,t} x_{k,t-1}}{\sum_k \left(n_{k,t} p^*_{k,t} x_{k,t-1}\right)} \right) \left(\frac{p_{k,t} x_{k,t}}{p^*_{k,t} x_{k,t-1}} + y_{k,t} \right)$$

$$= RI_{t-1} \cdot \sum_k w^*_{k,t} \left(\frac{p_{k,t} x_{k,t}}{p^*_{k,t} x_{k,t-1}} + y_{k,t} \right)$$

Alternative weighted indices

$$RI_t = RI_{t-1} \cdot \sum_k \left(\frac{q_{k,t} p^*_{k,t} x_{k,t-1}}{\sum_k \left(q_{k,t} p^*_{k,t} x_{k,t-1}\right)} \right) \left(\frac{p_{k,t} x_{k,t}}{p^*_{k,t} x_{k,t-1}} + y_{k,t} \right)$$

$$= RI_{t-1} \cdot \sum_k w^*_{k,t} \left(\frac{p_{k,t} x_{k,t}}{p^*_{k,t} x_{k,t-1}} + y_{k,t} \right)$$

The relationship between a price index and a total return index can be expressed as:

$$\frac{RI_t}{RI_{t-1}} = \sum_k w^*_{k,t} \left(\frac{p_{k,t} x_{k,t}}{p^*_{k,t} x_{k,t-1}} + y_{k,t} \right) = \frac{PI_t}{PI_{t-1}} + \sum_k \left(w^*_{k,t} y_{k,t}\right)$$

Dividends (total amount D) are assumed to be reinvested on the close of the ex-date across all constituents in proportion to their closing weights; hence the weight change is similar to price indices:

Cap-weighted indices

$$\frac{w_{k,t}}{w^*_{k,t}} = \left(\frac{n_{k,t}p_{k,t}x_{k,t} + \frac{n_{k,t}p_{k,t}x_{k,t}}{\sum_k (n_{k,t}p_{k,t}x_{k,t})} * D}{\sum_k (n_{k,t}p_{k,t}x_{k,t}) + D} \right) \cdot \frac{\sum_k (n_{k,t}p^*_{k,t}x_{k,t-1})}{n_{k,t}p^*_{k,t}x_{k,t-1}}$$

$$= \frac{n_{k,t}p_{k,t}x_{k,t}}{\sum_k (n_{k,t}p_{k,t}x_{k,t})} \cdot \frac{\sum_k (n_{k,t}p^*_{k,t}x_{k,t-1})}{n_{k,t}p^*_{k,t}x_{k,t-1}}$$

$$= \frac{p_{k.t}x_{k,t}}{p^*_{k,t}x_{k,t-1}} \cdot \frac{PI_{t-1}}{PI_t}$$

Alternative weighted indices

$$\frac{w_{k,t}}{w^*_{k,t}} = \left(\frac{q_{k,t}p_{k,t}x_{k,t} + \frac{q_{k,t}p_{k,t}x_{k,t}}{\sum_k (q_{k,t}p_{k,t}x_{k,t})} * D}{\sum_k (q_{k,t}p_{k,t}x_{k,t}) + D} \right) \cdot \frac{\sum_k (q_{k,t}p^*_{k,t}x_{k,t-1})}{q_{k,t}p^*_{k,t}x_{k,t-1}}$$

$$= \frac{q_{k,t}p_{k,t}x_{k,t}}{\sum_k (q_{k,t}p_{k,t}x_{k,t})} \cdot \frac{\sum_k (q_{k,t}p^*_{k,t}x_{k,t-1})}{q_{k,t}p^*_{k,t}x_{k,t-1}}$$

$$= \frac{p_{k.t}x_{k,t}}{p^*_{k,t}x_{k,t-1}} \cdot \frac{PI_{t-1}}{PI_t}$$

where:

RI_t is the total return index level at time t

RI_{t-1} is the total return index level at time t-1

PI_t is the price index level at time t

PI_{t-1} is the price index level at time t-1

$p^*_{k,t}$ is the adjusted price of stock k

$p_{k,t}$ is the closing price of stock k at time t

$w^*_{k,t}$ is the adjusted weight of stock k at time t; it is also the target weight at each rebalancing for alternative weighted indices

$w_{k,t}$ is the weight of stock k at time t

$q_{k,t}$ is the free float adjusted target share count of stock k at time t

$y_{k,t}$ is the dividend yield of stock k (i.e. the dividend amount per share divided by the previous day's closing price)

$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t

$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1

Net Return Index

To calculate the Net Return Index we identify withholding taxes, defined by a tax rate τ_k and remove those taxes from the cash dividend. The withholding tax rate is unique to each country.

Index formula

The formula is presented using adjusted constituent's weight:

$$NR_t = NR_{t-1}\left(\frac{PI_t}{PI_{t-1}} + \sum_k w^*_{k,t}\left(1 - \tau_{k,t}\right)y_{k,t}\right)$$

Since the withholding taxes, like dividends, are assumed to be applied on the ex-date across all constituents in proportion to their closing market value, a weight growth is similar to price indices as follows: (Please refer to Section 3 "Total Return Index" for the detailed calculation process)

$$\frac{w_{k,t}}{w^*_{k,t}} = \frac{p_{k.t}x_{k,t}}{p^*_{k,t}x_{k,t-1}} \cdot \frac{PI_{t-1}}{PI_t}$$

where:
NR_t is the net return index level at time t
NR_{t-1} is the net return index level at time t-1
PI_t is the price index level at time t
PI_{t-1} is the price index level at time t-1
$p_{k,t}$ is the closing price of stock k at time t
$p^*_{k,t}$ is the adjusted price of stock k
$w^*_{k,t}$ is the adjusted weight of stock k at time t-1; it is also the target weight at each rebalancing for alternative weighted indices
$y_{k,t}$ is the dividend yield of stock k (i.e. the dividend amount per share divided by the adjusted stock price)
$\tau_{k,t}$ is the withholding tax rate
$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t
$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1

Index Currency Conversion Methodology

All versions (Price, Total Return and Net Return) of Scientific Beta Indices that are performed over a mono-currency regional universe are calculated in the currency of the regional universe.

By contrast, all versions (Price, Total Return and Net Return) of Scientific Beta Indices that are performed over multi-currency regional universes are calculated in USD and expressed in three other main currencies: GBP, EUR, and JPY.

We explain here our methodology to convert an index level expressed in one particular currency, to one of the other main currencies: USD, GBP, EUR, and JPY.

Over a single period, the return of index It in a base currency B, in an alternative currency L expressed in the base currency is:

$$R_{B,t} = \frac{\mathrm{I_t x_t}}{\mathrm{I_{t-1} x_{t-1}}} - 1$$

We then express the index level $\mathrm{XI_t}$ in an alternative currency as follows:

$$\mathrm{XI_t} = (1 + R_{B,t})\mathrm{XI_{t-1}}$$

where:
$\mathrm{I_t}$ is the index level expressed in base currency at time t
$\mathrm{I_{t-1}}$ is the index level expressed in base currency at time t-1
$\mathrm{XI_t}$ is the index level expressed in alternative currency at time t
$\mathrm{XI_{t-1}}$ is the index level expressed in alternative currency at time t-1
$\mathrm{x_t}$ is the spot exchange rate from index alternative currency into base currency at time t
$\mathrm{x_{t-1}}$ is the spot exchange rate from alternative currency into index base at time t-1

We note that spot exchange rates used by Scientific Beta for daily index calculations and conversions are WM/Reuters Rates Closing Spot Rates (the mid-point of closing bid and ask rates to five decimal places), taken Monday – Friday at 16:00 hours UK Time. For further details, please refer to WM Methodology Document.

Currency Hedged Indices

Currency Hedged Indices are designed to control the exposure of indices that contain foreign securities to the volatility of foreign exchange rates.

1.1. Principles of Passive Currency Hedging

The passive currency hedging uses foreign exchange forward contracts to neutralise the currency risk. By selling foreign exchange forward contracts, investors are able to lock in current forward rates. The potential FX gains (losses) from the forward contracts are offset by gains (losses) in the value of the currency adhered to the index value, thereby negating exposure to currency risk. We illustrate the principle of passive currency hedging strategy as follows:

Over a single period, the un-hedged return of an investor with a base currency B, holding a position in a foreign risky asset denominated in a local currency L expressed in the base currency is:

$$R_B^U = \frac{P_t S_t}{P_{t-1} S_{t-1}} - 1 = (1 + R_L)(1 + R_S) - 1 = R_L + R_S + R_L R_S$$

where:
R_B^U is the un-hedged return in base currency B
P_t is the asset price at the end of the period in local currency L
P_{t-1} is the asset price at the beginning of the period in local currency L
S_t is the FX spot price at the end of the period, i.e. the price of one unite of local currency L expressed in base currency B
S_{t-1} is the FX spot price at the beginning of the period
R_L is the asset return in local currency L
R_S is the FX spot return in base currency B

Selling a unit of local currency L forward contract at price F_{t-1} generates a P&L in the base currency B of $F_{t-1} - S_t$ at the end of the period, and thus a return of:

$$R_F = \frac{F_{t-1} - S_t}{S_{t-1}} = \pi_{t-1} - R_S$$

where:
R_F is the forward premium
$\pi_{t-1} = \frac{F_{t-1}}{S_{t-1}} - 1$ is the forward premium.
F_{t-1} is the forward price at the beginning of the period
S_t is the FX spot price at the end of the period
S_{t-1} is the FX spot price at the beginning of the period

A simple and robust approach consists in using full hedging, where all foreign currency exposure is deemed to be hedged back to the base currency. By selling a forward contract on the currency exposure, we obtain a hedged return:

$$R_B^H = R_B^U + R_F = R_L + \pi_{t-1} + R_L R_S$$

As full hedging is equivalent to neglecting the cross term $R_L R_S$ which is reasonable for sufficiently small time periods[1], it leads to:

$$R_B^H = R_L + \pi_{t-1} + R_L R_S \approx R_L + \pi_{t-1}$$

As shown above, the effect of full hedging is to replace the main term due to exchange rate fluctuations in the un-hedged return $\mathrm{R_S}$, with the deterministic forward premium π_{t-1}. One should note that we are not able to recover the local asset return $\mathrm{R_L}$ in the base currency, and that for instance, hedging foreign assets denominated in higher yielding currencies can lead to a significant underperformance.

1.2. Currency Hedged Indices

Scientific Beta Hedged Indices hedge each foreign currency in the index back to the home currency of the index by selling each foreign currency exposure against the home currency at forward price. On the last business day of each month, the exposure in each foreign currency is sold forward with a one month maturity. When the forward contracts mature, the resulting net cash flow is reinvested proportionally to the weights in the un-hedged index. During the month, the P&L of the hedging position is estimated by marking the forward contracts to market. The hedged index calculation is given by:

$$\mathrm{HI_t} = \mathrm{HI_{M-1}}\left[\frac{\mathrm{UI_t}}{\mathrm{UI_{M-1}}} + \sum_{\mathrm{L}\in\mathcal{L}} \frac{\mathrm{W_{L,M-1}}}{\mathrm{S_{L,M-1}}}\left(\mathrm{F_{L,M-1}} - \mathrm{F_{L,t}}\right)\right]$$

where:
$\mathrm{HI_t}$ is the current value of hedged index at time t
$\mathrm{HI_{M-1}}$ is the hedged index at the close of the last business day of the previous month
$\mathrm{UI_{M-1}}$ is the un-hedged index at the close of the last business day of the previous month
$\mathrm{UI_t}$ is the current value of un-hedged index at time t
$\mathcal{L}$ is a set of local currencies.
$\mathrm{W_{L,M-1}}$ is the sum of weights of assets denominated in currency L, at the close of the last business day of the previous month.
$\mathrm{S_{L,M-1}}$ is the Spot price of the currency L, at the close of the last business day of the previous month.
$\mathrm{F_{L,M-1}}$ is one-month forward price for the currency Lat the close of the last business day of the previous month.
$\mathrm{F_{L,t}}$ is the forward price of the currency L at time t.

[1] Schmittmann, Jochen, Currency Hedging for International Portfolios (June 2010). IMF Working Papers, Vol. , pp. 1-44, 2010.

Please note that for the simplicity the discount factor between the calculation date t and the last business day of the current month is set to be 1.

Since quoted forward prices are available for standard maturities only, forward interpolated prices enable to value a forward contract on a particular day intra month. F_t is therefore recovered by interpolated forward price $F_{odd,t}$. During the month F_t is used to mark to market the position the local currency L and is equal to the Spot rate of local currency L on the last day of the month. We perform linear interpolation between the spot rate and the one-month forward rate as follows:

$$F_{L,t} = F_{odd,t} = S_t + \left(F_{1-month,t} - S_t\right)\frac{N_{odd}}{N_{month}}$$

where:
$F_{odd,t}$ is the interpolated forward price at time t.
$F_{1-month,t}$ is one-month forward rate at time t
S_t is the FX spot price at time t
N_{odd} is the number of calendar days remaining until the last business day in the current month, excluding day t.
N_{month} is the number of calendar days in the current month

Adjustments for Corporate Actions

Corporate actions affect the total market value of the index. Below is the list of corporate actions considered by ERI Scientific Beta and the corresponding adjustments on Scientific Beta Equity Indices, including Adjusted Price, Market Value Change for Capitalisation Weighted Indices (MVC for CW) and Market Value Change for Alternative Weighted Indices (MVC for AW).

Recall the price index formula adjusted to corporate actions:

$$PI_t = PI_{t-1} \cdot \frac{\text{Index Closing Market Value}_t}{\text{Adjusted Index Initial Market Value}_t}$$

$$= PI_{t-1} \cdot \frac{\text{Index Closing Market Value}_t}{\text{Index Closing Market Value}_{t-1} + \Delta MVC_{t-1}}$$

where ΔMVC_{t-1} is the difference between the adjusted index initial market value at time t and the index closing market value at time t-1. In practice, the ΔMC_{t-1} in the formula is calculated at the stock level as $C_{k,t-1}$ and then integrated into the closing market value at time t-1 to derive the adjusted index initial market value at time t as follows:

$$PI_t = PI_{t-1} * \frac{\sum_k (n_{k,t}\, p_{k,t}\, x_{k,t})}{\sum_k (n_{k,t-1}\, p_{k,t-1}\, x_{k,t-1} + C_{k,t-1})}$$

$$= PI_{t-1} * \frac{\sum_k (n_{k,t}\, p_{k,t}\, x_{k,t})}{\sum_k (n_{k,t}\, p^*_{k,t}\, x_{k,t-1})}$$

where:
PI_t is the price index at time t
PI_{t-1} is the price index level at time t-1
$n_{k,t}$ is the number of shares outstanding of stock k at time t
$p_{k,t}$ is the closing price of stock k at time t
$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t
$n_{k,t-1}$ is the number of shares outstanding of stock k at time t-1
$p_{k,t-1}$ is the closing price of stock k at time t-1
$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1
$C_{k,t-1}$ is the adjustment to market value due to corporate action for stock k at time t-1
$p^*_{k,t}$ is the adjusted price of stock k

Corporate Action	Adjustment
Addition This refers to when a company is added to the index. Please note that Scientific Beta does not proceed to intra-quarter additions. Additions occur only during the quarterly review process	**Adjusted Price:** Adjusted Price equals to the price of newly added stock. $p^*_{l,t} = p_{l,t-1}$ **MVC for CW** $\Delta MVC_{t-1} = p_{l,t-1} \cdot n_{l,t-1}$ **MVC for AW** $\Delta MVC_{t-1} = 0$ <u>Treatment description:</u> The addition is effective on ex-date before the opening. The rebalancing weight is given in the pro forma index review file (.review). *Where $p_{l,t-1}$ is the closing stock price of added company l at time t-1; $n_{l,t-1}$is the free float adjusted number of shares outstanding of added company l at time t-1.*
Deletion This refers to when a company is deleted from the index either due to the quarterly investable universe review, a corporate action or a suspension [(1)].	**Adjusted Price:** No price adjustment needed. **MVC for CW** $\Delta MVC_{t-1} = -(p_{l,t-1} \cdot n_{l,t-1})$ **MVC for AW** $\Delta MVC_{t-1} = 0$ <u>Treatment description:</u> The deletion is effective on ex-date before the opening. The weight of the deleted constituent is distributed across the whole index pro-rata to the remaining constituents' weights. *Where $p_{l,t-1}$ is the closing stock price of deleted company l at time t-1; $n_{l,t-1}$is the free float adjusted number of shares outstanding of deleted company l at time t-1.*
Stock Split This signifies an increase in the share count of a company with a simultaneous reduction in its share price. The stock split will not change the market capitalisation of the company. **Stock Consolidation** This is the reverse operation of stock split. The shares of a company are decreased while the share price is simultaneously increased. In the end, the stock consolidation will not change the overall market capitalisation of the company. **Stock Dividend (mandatory) / Bonus Issue** This works in the same way as a stock split, but it is quoted in terms of the percentage of shares received in proportion to the total number of company shares.	**Adjusted Price:** $p^*_{k,t} = p_{k,t-1} \cdot n_A/n_B$ **MVC for CW** The adjustment is not needed since the number of shares and price changes are offsetting. $\Delta MVC_{t-1} = 0$ **MVC for AW** The adjustment is not needed since the number of shares and price changes are offsetting. $\Delta MVC_{t-1} = 0$ <u>Treatment description:</u> The weight of the constituent remains unchanged; the price is adjusted on ex-date before the opening. *Where $p_{k,t-1}$ is the closing stock price of company k at time t-1; n_A is the share count of company k before stock split; n_B is new share count of company k after stock split.*

Special Dividend

This is a cash distribution that is outside of the normal payment pattern regularly established by the company. Special dividends are typically larger than regular dividends and are quoted in terms of dividends per share.

Adjusted Price

The prices are adjusted at the opening of the effective date:

$p^*_{k,t} = p_{k,t-1}$ - *Dividend per share announced(converted in the stock currency)*

MVC for CW

$\Delta MVC_{t-1} = -$*Dividend per share announced (converted in the stock currency)** $n_{k,t-1}$.

MVC for AW

$\Delta MVC_{t-1} = 0$

Treatment description: The cash amount is reinvested on ex-date before the opening. It is reinvested in the stock that pays dividend, the weighting of the constituent remains unchanged, the price is adjusted on ex-date before the opening.

Where $p_{k,t-1}$ is the closing stock price of company k at time t-1; $n_{k,t-1}$is the free float adjusted number of shares outstanding of stock k at time t-1.

Rights Offering

This is when existing shareholders are given the right to buy a specified number of additional company shares at a subscription price within a set subscription timeframe. A rights offering is made to all existing shareholders and may be accepted in full, in part or rejected. It is usually issued as a ratio to the current shares held.

Case 1: The subscription price is equal to or greater than the closing price on the day before the effective date.

Case 2: The subscription price is lower than the closing price on the day before the effective date.

Case 1: As rational investor would not subscribe to the rights issue, no adjustment is needed in this case.

Case 2:

Adjusted Price

The prices are adjusted to reflect the increase in the market cap at the opening of the effective date:

$$p^*_{k,t} = \frac{n_{k,t-1}p_{k,t-1} + n_{l,t-1}p_{l,t-1}}{n_{k,t-1} + n_{l,t-1}}$$

MVC for CW

The increase in the market cap at the opening of the effective date:

$\Delta MVC_{t-1} = n_{l,t-1}p_{l,t-1}$

MVC for AW

$\Delta MVC_{t-1} = 0$

Treatment description: the weight of the constituent remains unchanged, the price is adjusted on ex-date before the opening.

Where $p_{k,t-1}$ is the closing stock price of company k at time t-1; $n_{k,t-1}$is the free float adjusted number of shares outstanding of stock k at time t-1; $n_{l,t-1}$is the numbers of rights; $p_{l,t-1}$ is the subscription price.

Spin-off

This is when a company A divests a subsidiary or division to set up a new and independent company B. Shares of the company B are distributed to the equity shareholders of the parent company A at a ratio established, and are allowed keep or sell those shares at their discretion.

Adjusted Price

The price of company A is adjusted to reflect the decline in the index market value:

$p^*_{A,k} = (n_{A,t-1}p_{A,t-1} - n_{B,t-1}p_{B,t-1})/n_{A,t-1}$

MVC for CW

There is a decline in the index market value:

$\Delta MVC_{t-1} = -n_{B,t-1}p_{B,t-1}$

MVC for AW

$\Delta MVC_{t-1} = 0$

Treatment description: The weight of the constituent remains unchanged, the price is adjusted on ex-date before the opening. The spun-off company is not added to the index.

Where $n_{A,t-1}$is the free float adjusted number of shares outstanding of company A;$p_{A,t-1}$ is the share price of company A.$n_{B,t-1}$is the free float adjusted number of shares outstanding of company B;$p_{B,t-1}$ is the share price of company B.

Change in Free-float number of shares This is when the free-float factor or the outstanding number of shares changes. Increasing (decreasing) the free-float number of shares increases (decreases) the (Cap Weighted) index market value. Please note that Scientific Beta does not revise intra-quarter the free float factors.	**Adjusted Price** No price adjustment needed. **MVC for CW** $\Delta MVC_{t-1} = p_{k,t-1}(n_{k,t} - n_{k,t-1})$ **MVC for AW** $\Delta MVC_{t-1} = 0$ *Where $p_{k,t-1}$ is the closing price of stock k at time t-1; $n_{k,t}$is the free float adjusted number of shares outstanding of company k at time t*
Share Repurchase / Buyback A company repurchases outstanding shares from the market, increasing the proportion of shares the company remaining shareholders own.	**Adjusted Price** The prices are adjusted to reflect the increase in the market cap at the opening of the effective date: $p^*_{k,t} = \frac{n_{k,t-1}p_{k,t-1} - n_{l,t-1}p_{l,t-1}}{n_{k,t-1} - n_{l,t-1}}$ **MVC for CW** The decrease in the market cap at the opening of the effective date: $\Delta MVC_{t-1} = -n_{l,t-1}p_{l,t-1}$ **MVC for AW** $\Delta MVC_{t-1} = 0$ Treatment description: No adjustment. *Where $p_{k,t-1}$ is the closing stock price of company k at time t-1; $n_{k,t-1}$is the free float adjusted number of shares outstanding of stock k at time t-1; $n_{l,t-1}$is the number of tendered shares;$p_{l,t-1}$ is the tender price.*
Merger or Acquisition A merger is the combination of two or more companies into one larger company while an acquisition is when an acquiring company buys the target company in order to assume control. Case 1: If the surviving company is already an index member, it is retained in the index. Case 2: If the surviving company is not an index member, it is removed from the index.	Case 1: If the surviving company is already an index member, it is retained in the index. **Adjusted Price** No price adjustment needed. **MVC for CW** There's an increase in the index market value: $\Delta MVC_{t-1} = p_{l,t-1} \cdot (n_B - n_A)$ **MVC for AW** $\Delta MVC_{t-1} = 0$ *Where $p_{l,t-1}$ is the closing stock price of surviving company l at time t-1; n_A is the free float adjusted number of shares outstanding of company l before merger or acquisition; n_B is the new free float adjusted number of shares outstanding of company l after merger or acquisition.* Case 2: If the surviving company is not an index member, it is removed. **Adjusted Price** No price adjustment needed **MVC for CW** There's a decrease in the index market value: $\Delta MVC_{t-1} = -(p_{l,t-1} \cdot n_{l,t-1})$ **MVC for AW :** $\Delta MVC_{t-1} = 0$ *Where $p_{l,t-1}$ is the closing stock price of removed company l at time t-1; $n_{l,t-1}$ is the free float adjusted number of shares outstanding of removed company l at time t-1.*

[1] In case of a constituent suspension, Scientific Beta will adopt one of the treatments listed below:

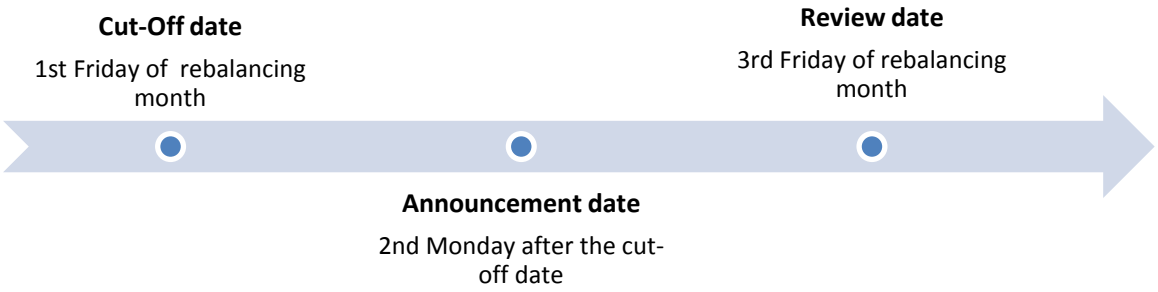
- If the company having issued the constituent has filed for bankruptcy without any indication of compensation to shareholders, the constituent will be removed from the index at a zero price;
- If the constituent is suspended for more than five days as of the cut-off date (first Friday of each rebalancing month), it will be automatically removed from Scientific Beta indices upon rebalancing. Its deletion price (either zero price [2] or newly available price) will depend whether the stock has resumed its quotation between the cut-off date and the effective date of the review. In any case, Scientific Beta will, at the latest, announce its decision on the Wednesday immediately preceding the effective date of the rebalancing;
- In all other cases, Scientific Beta monitors the suspension on a daily basis. The stock will remain included in Scientific Beta indices at its last traded price unless a decision is taken to delete the constituent at a zero price.

[2] Based on Scientific Beta calculation methodology, a stock deleted at a zero price will be valued at a 0.0001 price (stock local currency) at the close of the day preceding the deletion effective date. A minimum notice period of two days is applied; customers are notified through the usual replication files and a dedicated announcement email.

Quarterly review process

The ERI Scientific Beta indices are rebalanced at quarterly intervals in March, June, September and December. Each index is reviewed using data available at the close of trading on the first Friday of March, June, September and December. This date is referred to as the "Cut-Off Date". The output is new constituents and new weights.

On the second Monday following the Cut-Off Date ("the Announcement date"), Scientific Beta publishes files that contain universe changes. These Changes to the Universe are implemented on the "Review date" which is set after the close of the third Friday of March, June, September and December, respectively. Therefore, the next Monday is the effective date for these changes.



The index optimisation is performed using cut-off date prices; the output from this quarterly optimisation is the constituents' target weights $W_{k,q}$.

Up to 2015 June, these weights were implemented on the review date, i.e. after the close of the third Friday of the last month in the quarter, and therefore remained fixed over the period that spans between the cut-off date and the review date, called the review period. The target share number required to replicate the index was driven by these fixed weights $W_{k,q.}$

Since the 2015 September review, the target share number is determined on cut-off date (derived from $W_{k,q}$) and then locked across the review period. Every day during the review period, the constituents' daily weight $W_{k,t}$ (derived from the locked number of shares) add market drift to the optimal initial target $W_{k,q}$. In practice, the target share number is held constant during the review period, apart from corporate actions such as stock deletion, stock split, stock dividend, stock consolidation, right offering. In case of such a corporate action, the target share number is adjusted in the same proportion than the total outstanding number of shares.

Appendix 1: Index Calculation Methodology using Index Divisors

ERI Scientific Beta calculates the index level by adjusting the weighted average price movement of the index constituents to the previous index level. Traditionally, an index level is often calculated using index divisors. There are no conceptual differences between these two methodologies, only different ways of presenting the evolution of the index level. In this appendix, we present ERI Scientific Beta's calculation methodology for the price index level (capitalisation weighted indices) using the principle of index divisors as an example.

Index Formula

$$\mathrm{PI_t} = \frac{\text{Index Closing Market Value}_\mathrm{t}}{\text{Divisor}} = \frac{\sum_\mathrm{k}(\mathrm{n_{k,t}p_{k,t}x_{k,t}})}{\text{Divisor}}$$

where:
PI_t is the price index at time t
$n_{k,t}$ is the free float adjusted number of shares outstanding of stock k at time t
$p_{k,t}$ is the closing price of stock k at time t
$x_{k,t}$ is the exchange rate from local currency into index currency for stock k at time t

The numerator in the formula is the index closing market value at time t, calculated as the sum of the stock price multiplied by the number of shares used in the index. The denominator is the divisor, which sets the base value for calculating the index level.

Divisor Adjustments

Under ERI Scientific Beta implementation, the adjustments for corporate actions are reflected in the adjusted stock price p_k^*. Here, the index divisor plays a critical role to maintain the continuity of the index level when corporate actions occur. Adjustments are made to the divisor to eliminate the impact due to these corporate actions.

$$\text{Divisor}^* = \text{Divisor} \cdot \frac{\text{Adjusted Index Closing Market Value }_\mathrm{t}}{\text{Index Initial Market Value}_\mathrm{t}}$$

$$= \text{Divisor} \cdot \frac{\sum_\mathrm{k}(\mathrm{n_{k,t-1}p_{k,t-1}x_{k,t-1}} + \mathrm{C_{k,t-1}})}{\sum_\mathrm{k}(\mathrm{n_{k,t-1}p_{k,t-1}x_{k,t-1}})}$$

where:
$n_{k,t-1}$ is the free float adjusted number of shares outstanding of stock k at time t-1
$p_{k,t-1}$ is the closing price of stock k at time t-1
$\mathrm{C_{k,t-1}}$ is the adjustment to market value due to corporate action for stock k at time t-1
$x_{k,t-1}$ is the exchange rate from local currency into index currency for stock k at time t-1

Appendix 2: Withholding Tax Rates by Country (As of Feb 27th 2017)

Country Code	Incorporation Country	Withholding Tax Rate	From	To	SubCase
AE	United Arab Emirates	0	2014-06		
AT	Austria	27.5	2016-03		
		25	2002-06	2016-03	
AR	Argentina	0	2002-06	2010-06	
AU	Australia	30	2002-06		(a)
BE	Belgium	30	2017-01		
		27	2016-03	2016-12	
		25	2002-06	2016-03	
BM	Bermuda	0	2002-06		
BR	Brazil	0	2002-06		(c)
CA	Canada	25	2002-06		
CH	Switzerland	35	2002-06		(b)
CL	Chile	35	2007-01		
		18	2002-06	2007-01	
CN	China	10	2002-06		
CO	Colombia	0	2007-01		
		7	2002-06	2007-01	
CW	Curacao	0	2002-06		
CY	Cyprus	0	2002-06		
CZ	Czech Republic	15	2002-06		
DE	Germany	26.375	2009-01		
		21.1	2002-06	2008-12	
DK	Denmark	27	2012-01		
		28	2002-06	2011-12	
EG	Egypt	10	2015-01		
		0	2002-06	2015-01	
ES	Spain	19	2016-01		
		19.5	2015-08	2015-12	
		20	2015-01	2015-08	
		21	2012-01	2015-01	
		19	2010-01	2011-12	
		18	2007-01	2009-12	
		15	2003-01	2006-12	
		18	2002-06	2002-12	
FI	Finland	30	2012-01		
		28	2008-01	2011-12	
		29	2002-06	2007-12	
FR	France	30	2012-01		
		25	2002-06	2011-12	
GA	Gabon	20	2002-06		
GB	United Kingdom	0	2002-06		
		20	2002-06		UK - REITs
GG	Guernsey	0	2002-06		

Country Code	Incorporation Country	Withholding Tax Rate	From	To	SubCase
GR	Greece	15	2017-01		
		10	2013-01	2016-12	
		25	2011-01	2012-12	
		10	2009-01	2010-12	
		0	2002-06	2008-12	
HK	Hong Kong	0	2002-06		
HU	Hungary	0	2006-01		
		20	2002-06	2006-01	
ID	Indonesia	20	2002-06		
IE	Ireland	20	2002-06		
IL	Israel	25	2012-01		
		20	2006-01	2011-12	
		25	2002-06	2005-12	
IN	India	0	2002-06		
IM	Isle of man	0	2002-06		
IT	Italy	26	2014-07		
		20	2012-01	2014-06	
		27	2002-06	2011-12	
JE	Jersey	0	2002-06		
JP	Japan	15.315	2014-01		
		7.147	2013-01	2013-12	
		7	2004-01	2012-12	
		10	2003-04	2003-12	
		20	2002-06	2003-03	
KR	Korea, republic of	22	2009-01		
		27.5	2002-06	2008-12	
KY	Cayman islands	0	2002-06		
KZ	Kazakhstan	15	2002-06		
LI	Liechtenstein	0	2011-01		
		4	2002-06	2010-12	
LR	Liberia	15	2002-06		
LU	Luxembourg	15	2007-01		
		20	2002-06	2006-12	
MA	Morocco	15	2014-01	2014-06	
		10	2002-06	2014-01	
MH	Marshall islands	0	2002-06		
MT	Malta	0	2002-06		
MU	Mauritius	0	2002-06		
MX	Mexico	10	2014-01		
		0	2002-06	2014-01	
MY	Malaysia	0	2002-06		
NL	Netherlands	15	2007-01		
		25	2002-06	2006-12	
NO	Norway	25	2002-06		

Country Code	Incorporation Country	Withholding Tax Rate	From	To	SubCase
NZ	New Zealand	15	2002-06		(a)
PA	Panama	10	2002-06		
PE	Peru	4.10	2002-06		
PG	Papua New Guinea	17	2002-06		
PK	Pakistan	12.5 10	2017-06 2002-06	 2008-06	
PH	Philippines	30 35 32	2009-01 2006-01 2002-06	 2009-01 2006-01	
PL	Poland	19	2002-06		
PR	Puerto Rico	10	2002-06		
PT	Portugal	25 21.5 20 25	2012-01 2011-01 2006-01 2002-06	 2011-12 2010-12 2005-12	
QA	Qatar	0	2014-06		
RU	Russia	15	2002-06		
SE	Sweden	30	2002-06		
SG	Singapore	0 10	2002-06 2002-06		 Singapore - REITs
TH	Thailand	10	2002-06		
TR	Turkey	15 10	2007-01 2002-06	 2007-01	
TW	Taiwan	20 25	2010-01 2002-06	 2010-01	
US	United States	30	2002-06		
VG	Virgin Islands (British)	0	2002-06		
ZA	South Africa	20 15 0	2017-02 2012-04 2002-06	 2017-02 2012-04	

(a) AU / NZ : Franked portion of dividends and Conduit Foreign Income are not subject to withholding tax

(b) CH : Dividends paid out of capital reserves are not subject to Swiss withholding tax

(c) BR : Interest on Capital are subject to a 15% withholding tax

For more information, please contact:
Séverine Cibelly on: +33 493 187 863 or by e-mail to: severine.cibelly@scientificbeta.com

ERI Scientific Beta HQ & Asia
1 George Street
#07-02
Singapore 049145
Tel: +65 6438 0030

ERI Scientific Beta R&D
393 promenade des Anglais
BP 3116 - 06202 Nice Cedex 3
France
Tel: +33 493 187 863

ERI Scientific Beta—Europe
10 Fleet Place, Ludgate
London EC4M 7RB
United Kingdom
Tel: +44 207 871 6742

ERI Scientific Beta—North America
One Boston Place, 201 Washington Street
Suite 2608/2640, Boston, MA 02108
United States of America
Tel: +1 857 239 8891

ERI Scientific Beta—Japan
East Tower 4th Floor, Otemachi First Square,
1-5-1 Otemachi, Chiyoda-ku, Tokyo 100-0004
Japan
Tel: +81 352 191 418

www.scientificbeta.com

Scientific Beta
An EDHEC-Risk Institute Venture