# MSCI HEDGED INDEXES
# MSCI DAILY HEDGED INDEXES
# MSCI FX HEDGE INDEXES
# MSCI GLOBAL CURRENCY INDEXES
# MSCI ADAPTIVE HEDGE INDEXES

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## INTRODUCTION

This methodology book covers the following indexes:

- MSCI Hedged Indexes, described in section 2, aim to represent the return resulting from hedging an MSCI Equity Index in the 1-month Forward currency market and contain both an equity and a currency component. The intra month performance of the parent equity index remains unhedged and the currency P&L is assumed to be reinvested at month end only
- MSCI Daily Hedged Indexes, described in section 3, also contain both an equity and a currency component. Tomorrow Next Forward rates are used for hedging and the currency P&L is assumed to be reinvested daily
- MSCI FX Hedge Indexes, described in section 4, aim to measure the impact on performance of hedging the currency exposure of MSCI Equity Indexes and contain only a currency component
- MSCI Global Currency Indexes, described in section 5, aim to measure the total return of currencies of an MSCI Equity Index and reflect both currency appreciation / depreciation and interest accruing from holding the currencies
- MSCI Adaptive Hedge Indexes, described in section 6, aim to represent the return resulting from hedging an MSCI Equity Index in the 1-month Forward currency market and contain both an equity and a currency component wherein the portion of currency exposure to be hedged is determined by a multi factor currency model.

Section 1 describes the common principles used for the calculation of all of the above-mentioned indexes.

# 1 COMMON PRINCIPLES IN THE CALCULATION OF MSCI HEDGED, MSCI DAILY HEDGED, MSCI FX HEDGE AND MSCI GLOBAL CURRENCY INDEXES

## 1.1 CURRENCY DATA

### 1.1.1 CLOSING SPOT RATES

MSCI uses the WM/Reuters closing Spot rates (the mid-point of closing bid and ask rates to five decimal places), taken at 4 p.m. UK time in the daily index calculation and also in the determination of the notional amount of currencies to be sold forward on the roll date.

The WM/Reuters closing Spot rates are provided by the WM Company plc in conjunction with Reuters. MSCI may elect to use alternative sources of exchange rates if the WM/Reuters rates are not available, or if MSCI determines that the WM/Reuters rates may not reflect market conditions.

### 1.1.2 CLOSING FORWARD RATES

MSCI uses the mid values of the 1-month, 1-week and TN (tomorrow next) Forward exchange rates published by WM/Reuters at 4 p.m. UK time.

### 1.1.3 MISSING SPOT OR FORWARD RATES

In the case WM/Reuters does not provide Spot rates for specific markets on given days (for example, Christmas Day and New Year Day), the previous business day's Spot rates will be used. If a Forward premium/discount is missing, previous business day's premium/discount will be used.

### 1.1.4 CURRENCY CRISIS

If there is a disruption in the currency Spot and/or Forward market, MSCI will analyze the situation and will make a decision to continue or discontinue the inclusion of a currency in the indexes on a case by case basis. Should this happen, the decision will be announced to clients with sufficient advance notice.

This treatment potentially could result in currencies of certain countries being excluded from the MSCI Hedged, MSCI Daily Hedged, MSCI FX Hedge and/or MSCI Global Currency Indexes even though they may be still included in the parent MSCI Equity Indexes. In this case, the resulting currency weights may be different from the currency weights in the parent MSCI Equity Index.

## 1.2 CALCULATION TIME AND FREQUENCY

The MSCI Hedged, MSCI Daily Hedged, MSCI FX Hedge and MSCI Global Currency Indexes are calculated at the same time as the underlying MSCI Equity Index. In real time, their calculation begins as soon as the parent MSCI Equity Index is open and calculating, and ends as soon as the WM / Reuters data is available, or when the parent MSCI Equity Index calculation is finished and validated, whichever comes later[1].

More details about calculation time and frequency of MSCI indexes can be found in the MSCI Index Calculation Methodology available on MSCI's web site at www.msci.com.

Similar to the MSCI Equity Index calculation schedule, the official month-end index level for the MSCI Hedged, MSCI FX Hedge and MSCI Global Currency Indexes is calculated on the last weekday of the month.

[1] The MSCI Daily Hedged Indexes are currently not calculated in real time

# 2 MSCI HEDGED INDEXES

## 2.1 OVERVIEW

MSCI calculates Hedged Indexes for each Developed Market country as well as several Emerging Markets (on a custom basis) and for Developed Markets regional indexes, including the MSCI EAFE Index. MSCI Hedged Indexes are designed to represent a close estimation of the return that can be achieved by hedging the currency exposures of the index in the one-month Forward market at each end of month. The MSCI Hedged Indexes hedge each foreign currency in the index back to the home currency of the index by selling each foreign currency forward at the one-month Forward rate. The amount of Forwards sold on the last business day of the month represents the value (or the market capitalization) of the index as of the close of two business days before the first calendar day of the following month with the aim of achieving better index replicability. The foreign currency weights, however, take into account any changes in the composition of the index implemented as of the close of last business day of the month. No adjustment to the hedge is done during the month to account for changes in the indexes due to price movement of securities, corporate events, additions, deletions or any other changes. In other words the amount hedged is kept constant over the whole month. This simple approach replicates the hedging process in place in many actual portfolios.

Before May 2002, the MSCI Hedged Indexes were computed on a monthly basis only.

Before November 2009, the MSCI Hedged Indexes were using foreign currency weights and corresponding Forward notional amounts determined on the last business day of the month.

## 2.2 CONSTRUCTING THE MSCI HEDGED INDEXES

Constructing the MSCI Hedged Indexes involves the following steps:

- Defining the home currency
- Identifying the currencies to be sold
- Identifying the weight for each currency to be sold in the index
- Combining the unhedged parent MSCI Equity Index return with the Hedge Impact

### 2.2.1 DEFINING THE HOME CURRENCY

The home currency is the home currency of an investor investing in international equity markets. Often, a cross-border investor would like to measure the performance impact of hedging the currency exposure of his holdings relative to his home currency. For

construction of MSCI Hedged Indexes the default home currency is the US Dollar. The MSCI Hedged Indexes can also be constructed against any home currency.

#### 2.2.2 IDENTIFYING THE CURRENCIES TO BE INCLUDED IN THE INDEX

MSCI Equity Indexes have security constituents that can be quoted in different foreign currencies. Each foreign currency used to denote securities in the underlying MSCI Equity Index is included in the calculation of the MSCI Hedged Indexes. For example, for a US-based investor who is investing in the MSCI Emerging Markets Index, the calculation would combine the unhedged MSCI Emerging Markets index return in US dollars (USD) with the performance impact of hedging the currency exposure of the 21 currencies of the MSCI Emerging Markets Index relative to the US Dollar.

#### 2.2.3 IDENTIFYING THE WEIGHT OF EACH CURRENCY IN THE INDEX

In the MSCI Hedged Indexes, the weight of each currency corresponds to the relative market cap weight of the securities quoted in that currency in the underlying MSCI Equity Index. More precisely, the weights are derived from the aggregate free-float adjusted market capitalization of the securities quoted in the respective currencies in the underlying MSCI Equity Index as of the close of two business days before the first calendar day of following month, but taking into account any month end changes in the index constituents due to rebalancing and corporate actions.

#### 2.2.4 COMBINING THE UNHEDGED PARENT MSCI EQUITY INDEX WITH THE HEDGE IMPACT

The MSCI Hedged Index return is calculated as a sum of the parent MSCI Equity Index return expressed in the home currency, and the Hedge Impact. As currency weights and corresponding Forward notional amounts are determined two business days before the first day of the following month, an adjustment factor needs to be introduced in the calculation of the Hedge Impact to account for the performance of the MSCI Hedged Index on the last business day of the month. This adjustment is described in details in section 2.4.

### 2.3 MAINTAINING THE MSCI HEDGED INDEXES

The MSCI Hedged Indexes are maintained with an objective of reflecting the evolution of the underlying currency exposures in the MSCI Equity Indexes on a timely basis. In particular, index maintenance involves:

- Resetting the weights of the currencies to be sold in the index
- Rolling the Forward contracts over to the next month

The MSCI Hedged Indexes are rebalanced monthly on the last trading day of the month, when the index will take into account the effect of rolling into new 1-month Forward contracts based on the newly determined weights of currency to be sold for the next month's index calculation. The currency weights and corresponding foreign currency notional amounts are determined as of the close of two business days before the first calendar day of following month and remain constant intra month. This means that no changes in the weights are made during the month to account for changes in the indexes due to price movement of securities, corporate events, additions, deletions or any other changes.

## 2.4 MSCI HEDGED INDEX CALCULATION FORMULA

### 2.4.1 CALCULATION FORMULA

There are two components to a MSCI Hedged Index return:

1. The performance of the unhedged index in the home currency
2. The Hedge Impact (aimed to represent the gain or loss on the Forward contracts) in the home currency

The Hedge Impact, expressed in percent, is calculated as follows (all exchange rates are expressed as amount of foreign currency for 1 unit of hedged currency):

$$HI(t) = NAF \times \sum_{i=1}^{n} \left\{ Weight_{i,M-2} \times FXRate_{i,M-2} \times \left( \frac{1}{FFRate_{i,M-1}} - \frac{1}{FFRate_{i,odd-days_t}} \right) \right\}$$

where

$t$ = Index calculation date

$NAF$ = Notional Adjustment Factor that accounts for the fact that the total value of the currency notional amount is not the same as the value of the MSCI Equity Index due to the fact that the first is determined on M-2 whereas the second on M-1. It is defined as the ratio of the Hedged Index level on M-2 and the Hedged Index level on M-1

$$= \frac{HedgedIndex_{M-2}}{HedgedIndex_{M-1}}$$

$M$ = First calendar day of the month

$HI(t)$ = Index Hedge Impact at time t

$Weight_{i,M-2}$ = Weight of the currency i in the underlying MSCI Equity Index two business days before the start of the current calendar month, but reflecting changes

in the composition of the index to be implemented as of the close of the last business day of the previous month

$FXRate_{i,M-2}$ = Spot rate of the currency i two business days before the start of the current calendar month. This term determines the notional amount of the foreign currency to be sold corresponding to its weight in the index

$FFRate_{i,M-1}$ = 1-month Forward for the currency i one business day before the start of the current calendar month (or last business day of the previous calendar month)

$FFRate_{i,odd-days_t}$ = Interpolated odd-days Forward rate of the currency i on day t. This term is used to mark to market the currency position intra month and is equal to the Spot rate of currency i on the last day of the month. Its calculation is defined in Section 2.6.1.

The Hedged Index performance is the combination of the unhedged performance (in hedged currency terms) and the Hedge Impact:

Performance of the Hedged Index =

$$\frac{EquityIndex_t}{EquityIndex_{M-1}} - 1 + HI(t)$$

where

$EquityIndex_t$ = Value of the unhedged MSCI Equity Index on the calculation date

$EquityIndex_{M-1}$ = Value of the unhedged MSCI Equity Index on the last business day of the previous calendar month

$HI(t)$ = Hedge Impact on the index calculation date defined above

### 2.4.2 CALCULATION EXAMPLE

We consider a simple example of calculation of a two currency index hedged to USD. We describe the hypothetical calculation of the MSCI Hedged Index level for December 31, 2009. The data relevant for this calculation is displayed below.

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| | CHF weight | EUR weight | CHF spot | EUR spot | CHF 1-M fwd | EUR 1-M fwd | CHF odd-days fwd | EUR odd-days fwd | Hedged Index Level (USD) | Parent Index Level (USD) |
| 27-Nov | 35% | 65% | 1.00 | 0.70 | | | | | 1010 | |
| 30-Nov | | | | | 0.95 | 0.76 | | | 1005 | 1500 |
| 31-Dec | | | 0.90 | 0.80 | | | 0.90 | 0.80 | | 1550 |

The Notional Adjustment Factor is 1010/1005 = 1.005 in this case and the Hedge Impact is calculated as follows:

$$HI(Dec31) = 1.005 \times \left[35\% \times 1.00 \times \left(\frac{1}{0.95} - \frac{1}{0.90}\right) + 65\% \times 0.70 \times \left(\frac{1}{0.76} - \frac{1}{0.80}\right)\right] = 0.9513\%$$

The Hedged Index performance (month-to-date) for December 31 is

$$Perf(Dec31) = \frac{1550}{1500} - 1 + 0.9513\% = 4.28\%$$

leading to a Hedged Index level of 1005 x (1 + 4.28%) = 1048 on December 31.

## 2.5 CALCULATION OF DAILY RETURNS

### 2.5.1 MARKING TO MARKET THE FORWARD CONTRACTS ON A DAILY BASIS

The daily calculation of MSCI Hedged Indexes marks to market the one-month Forward contracts on a daily basis by using an equal and offsetting Forward position. For instance, after 8 days, the Forward would be marked to market using a 22-days offsetting Forward in the case of a month when the last business day of the month is the 30th (i.e. 30 – 8 = 22).

### 2.5.2 PRICING THE OFFSETTING FORWARD

Typically, only a limited number of standard duration of Forwards is available in the market. These rates are called "tenors", and represent one day, one week, one month, etc. This means that other durations for Forwards (called odd-days Forwards) are generally not available, but must be calculated. For the sake of simplicity, when calculating MSCI Hedged Indexes, MSCI uses a linear interpolation based solely on the 1-month Forwards to estimate the value of odd-days Forwards every day during the whole month. Odd-days Forwards are computed simply as the Spot rate plus the 1-month Forward premium or discount pro-rated for the number of days until the last business day of the month.

## 2.6 ODD-DAYS FORWARDS CALCULATION USING A LINEAR INTERPOLATION

### 2.6.1 CALCULATION FORMULA

MSCI uses a linear interpolation formula to compute odd-days Forwards. The general formula is as follows:

$$FFRate_{odd-days_t} = FXRate_t + \left(\left(FFRate_{1-month_t} - FXRate_t\right) \times \frac{Odd - days_t}{TotNbOfCalDaysDuringMonth}\right)$$

where

$FXRate_t$ = Spot rate at time $t$

$FFRate_{1-month_t}$ = 1-Month Forward rate at time $t$

$Odd - days_t$ = Number of days until the last business day of the current month (not counting $t$)

### 2.6.2 CALCULATION EXAMPLE

To compute a linear interpolation, the following process is used, using as an example data as of February 12, 2002:

a) Obtain the date of the last business day of the month, in our example February 28, 2002.

b) Check if today is the last business day of the month, in which case, the Spot exchange rate is used and there is no need to compute a linear interpolation.

c) Obtain the 1-month Forward rate as of today, i.e. February 12, 2002, for example 1.5915 CAD / USD. This Forward settles in one month.

d) Compute the price difference between the Spot and the 1-month Forward, as of today, February 12, 2002, called the premium (or discount). In this example, the Spot is at 1.5912, so the premium is 0.0003.

e) Using a linear interpolation, compute the value, as of today, February 12, 2002, of a Forward with a duration equal to the number of days until the last business day of the month. In our example, the last business day of the month is the 28th, so the duration of the Forward is 28-12 = 16 days.

The value of a 16 day Forward is estimated as the Spot rate plus the premium pro rated for the period. The total number of days taken into account is the number of days in the month, in our example 28, as there are 28 days in February 2002.

Interpolated value of a Forward for 16 days

= 1.5912 + 0.0003*(16 / 28)

= 1.5912 + 0.00017

= 1.59137

# 3 MSCI DAILY HEDGED INDEXES

## 3.1 OVERVIEW

MSCI Daily Hedged Indexes are designed to represent a close estimation of the return that can be achieved by hedging the currency exposures of the index using daily Forwards. The MSCI Daily Hedged Indexes hedge each foreign currency in the index back to the home currency of the index by selling each foreign currency forward at the TN (Tomorrow Next) Forward rate each day. To ensure better index replicability, the amount of Forwards sold represents the value (or the market capitalization) of the index on the previous day and currency P&L is assumed to be reinvested in the index with a one day lag.

The MSCI Daily Hedged Indexes can be constructed for any developed and emerging market index. Due to data availability, however, the MSCI Daily Hedged Indexes cannot include the following emerging market currencies as of May 2013: BRL, CLP, COP, EGP, KRW, MXN, PEN and TWD.

## 3.2 CONSTRUCTING THE MSCI DAILY HEDGED INDEXES

Constructing the MSCI Daily Hedged Indexes involves the following steps:

- Defining the home currency
- Identifying the currencies to be sold
- Identifying the weight for each currency to be sold in the index

### 3.2.1 DEFINING THE HOME CURRENCY

The home currency is the home currency of an investor investing in international equity markets. The default home currency for the MSCI Daily Hedged Indexes is the US Dollar. The Indexes can also be constructed against any home currency.

### 3.2.2 IDENTIFYING THE CURRENCIES TO BE INCLUDED IN THE INDEX

MSCI Equity Indexes have security constituents that can be quoted in different foreign currencies. Each foreign currency used to denote securities in the underlying MSCI Equity Index is included in the calculation of the MSCI Daily Hedged Indexes.

#### 3.2.3 IDENTIFYING THE WEIGHT OF EACH CURRENCY IN THE INDEX[2]

In the MSCI Daily Hedged Indexes, the weight of each currency corresponds to the relative market cap weight of the securities quoted in that currency in the underlying MSCI Equity Index as of two days prior to the calculation day, but taking into account any confirmed changes in index constituents due to rebalancing and corporate events as of the close of the previous day.

## 3.3 MSCI DAILY HEDGED INDEX CALCULATION FORMULA

### 3.3.1 CALCULATION FORMULA

The MSCI Daily Hedged Index is calculated as follows:

$$HL(t) = (HL(t-1) - HPnL(t-1)) \times \frac{EL(t)}{EL(t-1)} + HPnL(t-1) + HPnL(t)$$

where

- HL(t) is the level of the MSCI Daily Hegded Index on day *t*
- EL(t) is the level of the Parent Equity Index on day *t* expressed in the home currency
- HPnL(t) is the hedging P&L on day t defined by

$$HPnL(t) = HL(t-2) \times HR \times \sum_{i=1}^{n} Weight_{i,t-2,t} \times FXRate_{i,t-2} \times \left(\frac{1}{FFRate_{i,t-1}} - \frac{1}{FXRate_{i,t}}\right)$$

- $Weight_{i,t-2,t}$ is the weight of currency *i* in the Parent Equity Index at time *t-2*, taking into account any confirmed changes in index constituents due to rebalancing and corporate events as of the close of *t-1*
- $FFRate_{i,t}$ is the TN Forward rate for currency *i* on day *t*
- $FXRate_{i,t}$ is the Spot rate for currency *i* on day *t*
- $HR$ is the hedge ratio (1 by default)

For the first day of calculation after inception, both HPnL(t) and HPnL(t-1) are set to 0.

For the second day of calculation after inception, HPnL(t-1) is set to 0.

[2] On a custom basis, the parent equity index can be different from the equity index used to derive currency weights

### 3.3.2 CALCULATION EXAMPLE

We consider a simple example of calculation of MSCI USA hedged to CHF. We describe the hypothetical calculation of the MSCI Daily Hedged Index level for August 3, 2011. The data relevant for this calculation is displayed below.

| Date | USD Spot Rate | USD TN Forward Rate | MSCI USA Index Gross CHF | USD Weight | HPnL | Daily hedged Index |
|---|---|---|---|---|---|---|
| 8/1/2011 | 1.28033 | | | 100% | | 983.32 |
| 8/2/2011 | | 1.29653 | 3433.66 | | 12.21 | 958.46 |
| 8/3/2011 | 1.30506 | | 3429.49 | | | |

The hedging P&L for the 3rd of August is calculated as follows:

$$HPnL(Aug3) = 983.32 \times 100\% \times 100\% \times 1.2803 \times \left(\frac{1}{1.29653} - \frac{1}{1.30506}\right) = 6.35$$

The Daily Hedged Index level for August 3 is then calculated as follows

$$HL(Aug3) = (958.46 - 12.21) \times \frac{3429.49}{3433.66} + 12.21 + 6.35 = 963.66$$

# 4 MSCI FX HEDGE INDEXES

## 4.1 OVERVIEW

MSCI FX Hedge Indexes aim to measure the impact on performance of hedging the currency exposure of MSCI International Equity Indexes against an investor's home currency using a monthly Forward contract rollover. The index aims to measure the results of an investment process of selling each of the foreign currency exposures in the MSCI Equity Index against the home currency at one-month Forward rate on the last business day of the month. The amount of Forwards notionally sold for each currency is derived from the free-float adjusted market capitalization weights of the securities quoted in that currency in the corresponding MSCI Equity Index. The currency weights are fixed as of the close of two business days before the first calendar day of following month but taking into account any month end changes in the index constituents due to rebalancing and corporate actions. After one month, a similar process is performed for an amount representing the new market value of the index. No adjustments to the hedges are made during the month to account for changes in the indexes due to price movement of securities, corporate events, additions, deletions or any other changes. In other words the amount hedged is kept constant over the whole month.

To compute the daily index value, the Forwards are marked-to-market on a daily basis using a linear interpolation methodology based on Spot, 1-week and 1-month FX Forwards premium or discounts.

MSCI is currently offering the following FX Hedge Indexes:

- MSCI Emerging Markets FX Hedge Index in USD
- MSCI EAFE FX Hedge Index in USD

The methodology described in this section is a generic methodology that could be applied to create other FX Hedge Indexes against a home currency with weights derived from existing MSCI Equity Indexes.

The hedging methodology is identical to the MSCI Hedged Indexes except some differences in the way the Forwards are marked to market intra month.

## 4.2 CONSTRUCTING THE MSCI FX HEDGE INDEXES

Constructing the MSCI FX Hedge Indexes involves the following steps:

- Defining the home currency
- Identifying the currencies to be sold

- Identifying the weight for each currency to be sold in the index

#### 4.2.1 DEFINING THE HOME CURRENCY

The home currency is the home currency of an investor investing in international equity markets. Often, a cross-border investor would like to measure the performance impact of hedging the currency exposure of his holdings relative to his home currency. For construction of MSCI FX Hedge Indexes the default home currency is the US Dollar (USD). The MSCI FX Hedge Indexes can be constructed against any home currency.

#### 4.2.2 IDENTIFYING THE CURRENCIES TO BE INCLUDED IN THE INDEX

International MSCI Equity Indexes have security constituents that are quoted in different foreign currencies. Each foreign currency used to denote foreign securities in the underlying MSCI Equity Index is included in the calculation of the MSCI FX Hedge indexes. For example, for a US-based investor who is investing in emerging markets, MCSI calculates an MSCI Emerging Markets FX Hedge Index in USD, which measures the performance impact of hedging the currency exposure of the 21 emerging market currencies relative to the USD corresponding to the currencies of the 21 countries in the MSCI Emerging Markets Index.

#### 4.2.3 IDENTIFYING THE WEIGHT OF EACH CURRENCY IN THE INDEX

In the MSCI FX Hedge Indexes, the weight of each currency corresponds to the relative market cap weight of the securities quoted in that currency in the underlying MSCI Equity Index. More precisely, the weights are derived from the aggregate free-float adjusted market capitalization of the securities quoted in the respective currencies in the underlying MSCI Equity Index as of the close of two business days before the first calendar day of following month, but taking into account any month end changes in the index constituents due to rebalancing and corporate actions.

### 4.3 MAINTAINING THE MSCI FX HEDGE INDEXES

The MSCI FX Hedge Indexes are maintained with an objective of reflecting the evolution of the underlying currency exposures in the MSCI Equity Indexes on a timely basis. In particular, index maintenance involves:

- Resetting the weights of the currencies to be sold in the index
- Rolling the Forward contracts over to the next month

The MSCI FX Hedge Indexes are rebalanced monthly on the last trading day of the month, when the index will take into account the effect of rolling into new 1-month Forward contracts based on the newly determined weights of currency to be sold for the next

month's index calculation. The currency weights are determined as of the close of two business days before the first calendar day of following month and remain constant intra month This means that no changes in the weights are made during the month to account for changes in the indexes due to price movement of securities, corporate events, additions, deletions or any other changes.

## 4.4 MSCI FX HEDGE INDEX CALCULATION FORMULA

The FX Hedge Index aims to measure the performance impact of currency hedging which is calculated as the difference between the notional cost to hedge on the Forward contract and the notional gain or loss on the Spot exchange rate. The daily index calculation is given by:

$$FHI(t) = FHI(M-1) \times \left[1 + \sum_{i=1}^{n} \left\{ Weight_{i,M-2} \times FXRate_{i,M-2} \times \left( \frac{1}{FFRate_{i,M-1}} - \frac{1}{FFRate_{i,odd-days_t}} \right) \times DF(t) \right\} \right]$$

where:

$t$ = Index calculation date

$M$ = First calendar day of the month

$FHI(t)$ = FX Hedge index in the home currency at time $t$

$FHI(M-1)$ = FX Hedge index on the last day of the previous calendar month in the home currency

$Weight_{i,M-2}$ = Weight of the currency i in the underlying MSCI Equity Index two business days before the start of the current calendar month, but reflecting changes in the composition of the index to be implemented as of the close of the last business day of the previous month

$FXRate_{i,M-2}$ = Spot rate of the currency i two business days before the start of the current calendar month. This term determines the notional amount of the foreign currency to be sold corresponding to its weight in the index

$FFRate_{i,M-1}$ = 1-month Forward for the currency i one business day before the start of the current calendar month (or last business day of the previous calendar month)

$FFRate_{i,odd-days_t}$ = Interpolated odd-days Forward rate of the currency i on day t. This term is used to mark to market the currency position intra month and is equal to the Spot rate of currency i on the last day of the month. Its calculation is described in Section 4.6

$DF(t)$ = Discount factor between the calculation date (t) and the last business day of the current month, used to calculate the value at t of the Forward position and based on the one month London InterBank Offered Rates (LIBOR) rate in the home currency of the index. The source for LIBOR rates is the British Bankers' Association (BBA). More specifically, the value at time *t* of the Forward position initiated at time M-1 is determined by discounting the gain or loss relative to a new offsetting Forward contract initiated at time *t*, with the same delivery date as the original Forward contract. This discounted gain (loss) would be received (paid) by the investor as the original Forward contract is closed out at time *t*.

=

$$\frac{1}{\left(1+\frac{d}{360}\times LIBOR(1M)_t\right)}$$

d = the number of calendar days remaining until the last business day in the current month (not including day *t*)

## 4.5 CALCULATION OF DAILY RETURNS

### 4.5.1 MARKING TO MARKET THE FORWARD CONTRACTS ON A DAILY BASIS

The daily calculation of MSCI FX Hedge Indexes marks to market the one-month Forward contracts on a daily basis by using an equal and offsetting Forward position. For instance, after 8 days, the Forward would be marked to market using a 22-days offsetting Forward in the case of a month when the last business day of the month is the 30th (i.e. 30 – 8 = 22).

### 4.5.2 PRICING THE OFFSETTING FORWARD

Typically, only a limited number of standard duration of Forwards is available in the market. These rates are called "tenors", and represent one day, one week, one month, etc. This means that other durations for Forwards (called odd-days Forwards) are generally not available, but must be calculated. When calculating MSCI FX Hedge Indexes, MSCI uses a linear interpolation based both on the 1-week and 1-month Forwards to estimate the value of odd-days Forwards every day during the whole month. Odd-days Forwards are computed as the Spot (1-Week Forward) rate plus the premium or discount between the Spot (1-Week Forward) and the 1-Week Forward (1-month Forward), pro-rated for the number of days until the last business day of the month.

## 4.6 CALCULATION OF ODD-DAYS FORWARDS USING A LINEAR INTERPOLATION

### 4.6.1 CALCULATION FORMULA

- If the number of days until the last business day of the current month end is greater than 7, the interpolation will use the 1-week Forward rate and the 1-month Forward rate as follows:

$$FFRate_{odd-days_t} = FFRate_{1-week_t} + \left(FFRate_{1-month_t} - FFRate_{1-week_t}\right) \times \frac{Odd - days_t - 7}{TotNbOfCalDaysDuringMonth - 7}$$

- If the number of days until the last business day of the current month end is less than or equal to 7, the interpolation will use the current Spot rate and the 1-week Forward rate as follows:

$$FFRate_{odd-days_t} = FXRate_t + \left(FFRate_{1-week_t} - FXRate_t\right) \times \frac{Odd - days_t}{7}$$

where

$FFRate_{1-week_t}$ = 1-Week Forward rate at time *t*

$FFRate_{1-month_t}$ = 1-Month Forward rate at time *t*

$FXRate_t$ = Spot rate at time *t*

$Odd - days_t$ = Number of days until the last business day in the month (not including *t*)

### 4.6.2 CALCULATION EXAMPLE A

To compute a linear interpolation, the following process is used, using as an example data as of January 08, 2009:

a) Check if today is the last business day of the month, in which case, the Spot rate is used and there is no need to compute a linear interpolation.

b) Obtain the date of the last business day of the month, in our example January 30, 2009. See if there are more than 7 days left from today January 08, 2009 till the last business day of the month. If there are equal to or less than 7 days left from today till the last business day of the month, then the linear interpolation process is explained in example B.

c) Obtain the 1-week Forward and 1-month Forward rate as of today, e.g., on January 08, 2009, 1.18671, and 1.18720 CAD/USD. These Forwards settle in one week and one month from today. The total number of days taken into account is the number of days in the current month, in our example 31, as there are 31 days in January 2009. There are 31-7 = 24 days between the expiry of the 1-month and 1-week Forwards.

d) Compute the price difference between the 1-week Forward and the 1-month Forward, as of today, January 08, 2009. In this example, premium difference is 0.0005.

e) Compute the expiry date of the 1-week Forward which is 8+7=15

f) Using a linear interpolation, compute the value, as of today, January 08, 2009, of a Forward with a duration equal to the number of days until the last business day of the month. In our example, the last business day of the month is the January 30th, so the duration of the Forward from the expiry of the 1-week Forward is 30 - 15 = 15 days or 22 days from January 08, 2009.

The value of a 22 day Forward is estimated as the 1-week Forward rate plus the premium difference between 1-week and 1-month Forwards prorated for the period.

Interpolated value of a Forward settling in 22 days from today is:

= 1.18671 + 0.0005*(15/24)

= 1.18671 + 0.0003

= 1.1870

### 4.6.3 CALCULATION EXAMPLE B

If there are less than or equal to seven days from today till the next roll date to compute a linear interpolation, the following process is used, using as an example data as of January 25, 2009:

a) Check if today is the last business day of the month, in which case, the Spot exchange rate is used and there is no need to compute a linear interpolation.

b) Obtain the date of the last business day of the month, in our example January 30, 2009. See if there are less than or equal to 7 days left from today January 25, 2009 till the last business day of the month. If there are more than 7 days left from today till the last business day of the month, than linear interpolation process is explained in example A.

c) Obtain the Spot and 1-week Forward rate as of today, e.g., for January 25, 2009, 1.18645, and 1.18671 CAD/USD. The Forward settle in one week. There are fewer than 7 days between today and expiry of 1-week Forward.

d) Compute the price difference between the Spot and 1-week Forward, as of today, January 25, 2009. In this example, premium difference is 0.0003.

e) Using a linear interpolation, compute the value, as of today, January 25, 2009, of a Forward with a duration equal to the number of days until the last business day of the month. In our example, the last business day of the month is the January 30th, so the duration of the Forward is 30 - 25 = 5 days.

The interpolated value of a 5 day Forward is estimated as the Spot rate plus the premium prorated for the period.

Interpolated value of a Forward settling in 5 days from today is:

= 1.18645 + 0.0003*(5/7)

= 1.18645 + 0.0002

= 1.1867

# 5 MSCI GLOBAL CURRENCY INDEXES

## 5.1 OVERVIEW

MSCI Global Currency Indexes are designed to measure the total return of currencies of countries in a regional or composite MSCI Equity Index, weighed by their country weights. The total return reflects the currency appreciation/depreciation of the currencies included the Currency Index relative to the home currency and interest accruing from holding the currencies. For example, the MSCI Emerging Market Currency Index in US Dollar (USD) measures the total return of 21 emerging market currencies relative to the USD where the weight of each currency is equal to its country weight in the MSCI Emerging Markets Index.

The index aims to reflect an investment process that uses a combination of monthly trades of currency Forwards against the home currency and home currency LIBOR deposits to capture the currency and interest rate returns.

MSCI is currently offering the following Currency Indexes:

- MSCI Emerging Markets Currency Indexes in USD, Euro and Japanese Yen.
- MSCI EAFE Currency Index in USD.
- MSCI Europe Currency Index in USD.
- MSCI Asia Pacific ex Japan Currency Index in USD.

The methodology described in this guide is a generic methodology that could be applied to create other Currency Indexes against a home currency with weights derived from existing MSCI International Indexes.

## 5.2 CONSTRUCTING THE MSCI GLOBAL CURRENCY INDEXES

Constructing the MSCI Global Currency Indexes involves the following steps:

- Defining the home currency.
- Identifying the currencies in the index.
- Identifying the weight for each currency in the index.
- Determining the accrued interest rate for each currency in the index.

Each of these steps is described in detail below.

#### 5.2.1 DEFINING THE HOME CURRENCY

An investor investing in foreign exchange would like to measure the performance of his holdings relative to his home currency. For construction of MSCI Global Currency Indexes the default home currency is the US Dollar.

#### 5.2.2 IDENTIFYING THE CURRENCIES TO BE INCLUDED IN THE INDEX

The MSCI Global Currency Indexes can be constructed against any currency included in the index. For example, for benchmarking the returns of a US based investor who is investing in emerging market currencies, MCSI calculates an MSCI Emerging Markets Currency Index, which reflects the performance of 21 emerging market currencies relative to the USD.

#### 5.2.3 IDENTIFYING THE WEIGHT OF EACH CURRENCY IN THE INDEX

In the MSCI Global Currency Indexes, the currency weights are derived from the aggregate free float market capitalization of the countries in the underlying MSCI Equity Index. By default, these are determined as of the close of two business days before the first calendar day of the following month. These currency weights, however, take into account any changes in the composition of the index implemented as of the close of last business day of the month.

#### 5.2.4 DETERMINING THE ACCRUED INTEREST RATE FOR EACH CURRENCY IN THE INDEX

MSCI Global Currency Indexes reflect the currency appreciation/depreciation of currencies against a home currency as well as the interest earned by holding the currencies. To calculate interest, MSCI uses the accrued foreign interest rates from the Forward-Spot relation in the currency markets.

Please see section 5.4.2 for more details on the calculation of accrued foreign interest rates.

### 5.3 MAINTAINING THE MSCI GLOBAL CURRENCY INDEXES

The MSCI Global Currency Indexes are maintained with an objective of reflecting the evolution of the underlying country weights on a timely basis. In particular, index maintenance involves:

- Resetting the accrued foreign currency interest rates.
- Resetting the weights of the currencies included in the index.

The MSCI Global Currency Indexes are rebalanced monthly on the last trading day of the month, when the currency weights and accrued foreign interest rates are reset for the next month's index calculation.

#### 5.3.1 RESETTING THE ACCRUED INTEREST RATE FOR EACH FOREIGN CURRENCY IN THE INDEX

The accrued interest for each foreign currency is reset on the last trading day of the month. This new accrued interest rate is accrued in the index until the next rebalancing date, i.e. the last business day of the following month.

#### 5.3.2 RESETTING THE WEIGHTS OF CURRENCIES IN THE INDEX

The currency weights are determined two business days before the first calendar day of the following month and reset after the close of the last trading day of the month. They remain constant intra month, i.e. no changes in the weights are made during the month to account for changes in the indexes due to price movement of securities, corporate events, additions, deletions or any other changes.

### 5.4 MSCI GLOBAL CURRENCY CALCULATION

#### 5.4.1 INDEX CALCULATION FORMULA

There are two components to the Currency Index returns:

1. The performance (appreciation/depreciation) of the constituent currencies relative to the home currency.
2. The foreign currency deposit interest earned on the constituent currencies.

The Currency Index calculation formula is defined as follows

$$CI(t) = CI(M-1) \times \sum_i \left\{ Weight_{i,M-1} \times \frac{S_{i,t}}{S_{i,M-1}} \times \left(1 + R_{i,fgn,M-1} \times \frac{t}{360}\right)\right\}$$

where

$t$ = Index calculation date expressed as the number of days elapsed since the last rebalancing date (including weekends and non-trading days)

$M$ = First business day of the current month

$CI(t)$ = Currency Index at time $t$

$CI(M-1)$ = Currency Index one business day before the first day of current month

$Weight_{i,M-1}$ = Weight of currency i at time M-1

$S_{i,t}$ = Spot rate of currency i at time t

$S_{i,M-1}$ = Spot rate of currency i at time M-1

$R_{i,fgn,M-1}$ = Interest rate for currency i determined at time M-1 and defined below

### 5.4.2 ACCRUED FOREIGN INTEREST RATE CALCULATION FORMULA

The accrued foreign interest rate is calculated using the Forward-Spot relationship at the time of rebalancing.

$$R_{fgn,M-1} = \left\{\frac{S_{M-1}}{F_{M-1}}\left(1 + LIBOR(1M)_{M-1} \times \frac{D}{360}\right) - 1\right\} \times \frac{360}{D}$$

where

$S_{M-1}$ = Spot rate at time M-1

$F_{M-1}$ = 1-Month Forward rate at time M-1

$LIBOR(1M)_{M-1}$ = 1-Month home currency LIBOR rate (reset monthly).

$D$ = number of days between rebalancings, i.e., the difference in days between the last business day of the month and the previous month's last business day

### 5.4.3 HANDLING NON-TRADING DAYS AT MONTH END FOR INDEX AND ACCRUED INTEREST RATES CALCULATION

The official index level for each month is calculated on the last weekday of the month. The last weekday of the month may coincide with an official holiday of a constituent currency. But since currency markets will be open in other countries, the Currency Index will be calculated for that day.

- If the last day of next month is not a trading day.

For example to price a one month Forward on October 31, when the last trading day in November is the 29th, the days to maturity for Forwards will 29 days. This will be used as number of the days in the accrued interest rate formula.

The Currency Index will accrue interest in November for 29 days and the official index level for November will be calculated on the same date.

- If the last day of current month is not a trading day.

For example to price a one month Forward on November 29, which happens to be last trading day in November, the days to maturity for Forwards settling on December 31 will be 32days. This will be used as number of the days in the accrued interest rate formula. The Currency Index will accrue interest in December for 32 days. The first accrual will happen at the opening of index on December 1.

# 6 MSCI ADAPTIVE HEDGE INDEXES

## 6.1 OVERVIEW

Institutional investors who allocate to global equity portfolios may be exposed to currency risk as a result of fluctuations in exchange rates. Currency exposure can be hedged with a goal of mitigating that currency risk. The MSCI Hedged Indexes are designed to provide currency-hedged benchmarks where every currency-pair relative to the portfolio home currency is fully hedged.

These fully-hedged indexes may be used for hedging the impact of currency exposure of a global equity portfolio. However, currency fluctuations can also enhance the total returns associated with investments in a foreign currency. For instance, for a USD-denominated investor, if the USD depreciates against a particular foreign currency, then the portfolio returns in US dollars would be higher if currency exposure had been left unhedged.

The MSCI Adaptive Hedge Indexes aim to use versions of well-known currency factors (namely value, momentum, carry and volatility) to systematically determine a level of hedging (in the range from unhedged to fully hedged) to be applied for each foreign currency at each monthly rebalancing. The objective is to reflect a rule-based hedging strategy based on multiple currency factors. These factors are analogous to four of the six factors seen in equity markets for which MSCI has constructed factor indexes.

## 6.2 INDEX CONSTRUCTION METHODOLOGY

The construction details of the MSCI Adaptive Hedge Indexes are the same as for the MSCI Hedged Indexes with the difference being the portion of each currency exposure to be hedged every month. In the MSCI Hedged Indexes the full weight of each currency is hedged by selling a 1-month forward of each currency proportional to its weight. In the MSCI Adaptive Hedge Indexes, the level of hedging for each currency is determined by rules which consider signals from a combination of four currency factors: Value, Momentum, Carry and Volatility.

## 6.3 HEDGE RATIO

The hedge ratio is the ratio (portion) of each currency weight in the index that will be hedged each month and is calculated as the average of the four factor-level hedge ratios calculated for each of the four currency factors, according to the rules described below. The overall effect is that each currency pair relative to the investor home currency can be unhedged, 25% hedged, 50% hedged, 75% hedged or fully-hedged.

The formula used for calculation of MSCI Adaptive Hedge Indexes is same as specified in Section 2.4

$$HI(t) = NAF \times \sum_{i=1}^{n} \left\{ Weight_{i,M-2} \times FXRate_{i,M-2} \times \left( \frac{1}{FFRate_{i,M-1}} - \frac{1}{FFRate_{i,odd-days_t}} \right) \right\}$$

Where, the only change would be in the definition of $Weight_{i,M-2}$ as outlined below

$Weight_{i,M-2}$ = Hedge Ratio of the currency i * Weight of the currency i in the underlying MSCI Equity Index two business days before the start of the current calendar month, but reflecting changes in the composition of the index to be implemented as of the close of the last business day of the previous month

### 6.3.1 VALUE FACTOR

Mean reversion is the underlying basis of the Value factor. As such, if a currency has appreciated over time relative to Purchasing Power Parity (PPP)[3] between foreign and base currencies, the exchange-rate could mean-revert and therefore weaken in the future. In such a scenario, currency exposure would be hedged. The economic rationale is that over the long-term prices of goods should equalize to an equilibrium level adjusting for those exchange rates.

The Value factor signal is calculated by first computing a z-score of the following ratio: the average daily spot rate over the last three months (63 trading days) divided by the latest available PPP (Purchasing Power Parity) exchange rate. The z-score is calculated over a three-year lookback window using the monthly values of the average spot/PPP ratio. Also, at least one year history of z-scores would be needed for computation of Value factor hedge ratio else the respective currency exposure would be fully hedged.

A threshold of zero is used for the z-score in order to determine the hedge ratio. If the z-score is negative, it implies that the market exchange rate relative to PPP is low (relative to its history) and hence the currency may weaken to equalize purchasing power parity (which is the hypothesis behind the factor). Hence in line with the economic framing, the currency exposure would be hedged and the Value factor hedge ratio is set to one. Conversely, if the z-score is positive, this Value factor hedge ratio is set to zero.

[3] PPPs are the rates of currency conversion that equalize the purchasing power of different currencies by eliminating the differences in price levels between countries. PPPs are used to remove the effects of the different levels of prices within a group of countries at a point in time. Exchange rates are used to convert GDP in different currencies to a common currency. Data is sourced from OECD and World Bank and is updated annually.

### 6.3.2 MOMENTUM FACTOR

The Momentum factor is based on the economic hypothesis that currencies that have appreciated in the recent past will continue to appreciate reflecting persistent trends in macro-economic momentum, for example.

The Momentum factor signal is calculated using the return[4] of the foreign currency relative to the home currency over the previous 6 months as of the calculation date. If the exchange rate return is positive, then the hypothesis is that the foreign currency would continue to appreciate against the home currency. Hence the Momentum factor hedge ratio is set to zero. If this exchange rate return is negative, the Momentum factor hedge ratio is set to one. If enough history is not available for computation of Momentum factor hedge ratio, respective currency exposure would be fully hedged.

### 6.3.3 CARRY FACTOR

The Carry factor is based on the carry trade strategy of buying higher-yielding currencies with the funding provided by the low yielding currencies. The strategy historically outperformed when the adjustment implied by the difference in local interest rates has been relatively slow to occur.

The Carry factor signal is calculated by taking the difference between the two year sovereign yield rate in the foreign currency and the corresponding two year sovereign yield rate in the home currency. If the two year yields are not available, short-term rates for both foreign currency and the home currency are used to calculate the yield differential. If the yield differential (foreign currency yield less home yield) is positive, the foreign currency is attractive based on the "carry trade" rationale. The z-score of the current yield differential within a three-year lookback period is first calculated using the monthly values of the yield differential. A threshold of zero is used for the z-score to determine the hedge ratio. The Carry factor hedge ratio is set to one if the z-score is negative and is set to zero if it is positive. At least a one year history of z-scores would be needed for computation of hedge ratio otherwise the respective currency exposure would be fully hedged.

### 6.3.4 VOLATILITY FACTOR

Currency volatility can be a broader indicator of investor risk appetite in currency markets. As such, the Volatility factor can be used to express a view on risk-aversion and a desire to remove uncertainty by hedging currency exposure. While the first three factors are drawn from classic investment strategies used by investors targeting higher return through

[4] The spot rates used for computation of currency returns should be quoted as the number of units of foreign currency which can be purchased by a unit of the home currency

currency hedging, the volatility factor is focused on reducing the volatility of the index from the currency exposure.

The Volatility factor signal is calculated by comparing the short term average volatility of the exchange rate with its long term average. Daily volatility is computed using 22 day daily returns and this daily volatility is used for calculating the one month and six month averages. The one month volatility is computed by averaging the daily volatility for last 22 days and the six month volatility is computed by averaging the daily volatility for last 125 days. The Volatility factor hedge ratio is set to one if the volatility differential (the one-month average minus six-month average) is positive and it is set to zero if this differential is negative. If enough history is not available for computation of Volatility factor hedge ratio, respective currency exposure would be fully hedged.

## METHODOLOGY BOOK TRACKED CHANGES

The following sections have been updated since November 2009

**May 2011**

- Sections 5.2.3 and 5.3.2

  Update for currency weights being determined two business days before the first calendar day of the following month

- Sections 2.2.2, 3.2.2, 5.1 and 5.2.2

  Update to reflect the current (as of May 2011) number of currencies in the MSCI Emerging Markets Index

**July 2013**

- Added a section on the MSCI Daily Hedged Indexes methodology

**November 2015**

- Added a section on the MSCI Adaptive Hedge Indexes methodology

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