

MSCI HEDGED INDEXES MSCI DAILY HEDGED INDEXES MSCI ADAPTIVE HEDGE INDEXES

November 2018

CONTENTS

Introduction.....	4
1 Common Principles in the Calculation of MSCI Hedged, MSCI Daily Hedged and MSCI Adaptive Hedge Indexes.....	5
1.1 Currency Data.....	5
1.1.1 Closing Spot Rates.....	5
1.1.2 Closing Forward Rates.....	5
1.1.3 Missing Spot or Forward Rates	5
1.1.4 Currency Crisis	5
1.2 Calculation Time and Frequency	6
2 MSCI Hedged Indexes.....	7
2.1 Overview	7
2.2 Constructing the MSCI Hedged Indexes.....	7
2.2.1 Defining the Home Currency	7
2.2.2 Identifying the Currencies to be Included in the Index.....	8
2.2.3 Identifying the Weight of Each Currency in the Index.....	8
2.2.4 Combining the Unhedged Parent MSCI Equity Index with the Hedge Impact..	8
2.3 Maintaining the MSCI Hedged Indexes.....	8
2.4 MSCI Hedged Index Calculation Formula.....	9
2.4.1 Calculation Formula	9
2.4.2 Calculation Example.....	10
2.5 Calculation of Daily Returns	11
2.5.1 Marking to Market the Forward Contracts on a Daily Basis	11
2.5.2 Pricing the Offsetting Forward.....	11
2.6 Odd-Days Forwards Calculation Using a Linear Interpolation	11
2.6.1 Calculation Formula	11
2.6.2 Calculation Example.....	12

3	MSCI Daily Hedged Indexes	13
3.1	Overview	13
3.2	Constructing the MSCI Daily Hedged Indexes.....	13
3.2.1	Defining the Home Currency	13
3.2.2	Identifying the Currencies to be Included in the Index.....	13
3.2.3	Identifying the Weight of Each Currency in the Index	14
3.3	MSCI Daily Hedged Index Calculation Formula	14
3.3.1	Calculation Formula	14
3.3.2	Calculation Example.....	15
4	MSCI Adaptive Hedge Indexes	16
4.1	Overview	16
4.2	Index Construction Methodology	16
4.3	Hedge ratio.....	16
4.3.1	Value factor.....	17
4.3.2	Momentum factor	18
4.3.3	Carry factor	18
4.3.4	Volatility factor	18
	Appendix: Custom Indexes With Cash Adjustment	20
	Description	20
	Calculation formula – MSCI Hedged Indexes.....	20
	Calculation formula – MSCI Adaptive Hedge Indexes	22
	Methodology Book Tracked Changes	23

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, aim to represent the return resulting from hedging the currency exposures of the MSCI Equity Index using daily Forwards and 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 Adaptive Hedge Indexes, described in section 4, 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.

The Appendix describes how the MSCI Hedged Indexes and the MSCI Adaptive Hedge Indexes can be customized to incorporate a cash component in the index calculation.

1 COMMON PRINCIPLES IN THE CALCULATION OF MSCI HEDGED, MSCI DAILY HEDGED AND MSCI ADAPTIVE HEDGE 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 Thomson 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) WM/Reuters Forward rates published by Thomson Reuters at 4 p.m. UK time.

1.1.3 MISSING SPOT OR FORWARD RATES

In the case Thomson Reuters does not provide Spot rates for specific markets on given days (for example, Christmas Day and New Year Day), the Spot rates on the last weekday for which they are available will be used. If a Forward rate is missing, the Forward premium/discount on the last weekday for which it is available is applied to the current day's Spot rate.

1.1.4 CURRENCY CRISIS

Disruptions in the currency Spot and/or Forward market may potentially result in a currency being excluded from the MSCI Hedged, MSCI Daily Hedged, and MSCI Adaptive Hedge Indexes even though the currency 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.

In such circumstances, MSCI would send an announcement to clients with the related information and with sufficient advance notice. All such determinations are made by the MSCI Equity Index Committee (EIC). If appropriate, MSCI may conduct a consultation with the investment community to gather feedback on the treatment of the currency in the MSCI Hedged, MSCI Daily Hedged, and MSCI Adaptive Hedge Indexes.

1.2 CALCULATION TIME AND FREQUENCY

The MSCI Hedged, MSCI Daily Hedged, and MSCI Adaptive Hedge 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 rates are available, or when the parent MSCI Equity Index calculation is finished and validated, whichever comes later¹.

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 and MSCI Adaptive Hedge 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 weekday of the month represents the value (or the market capitalization) of the index as of the close of two weekdays 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 weekday 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 weekday 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 weekdays 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 weekdays 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 weekday 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 weekdays 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 weekdays 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 weekday of the previous month

$FXRate_{i,M-2}$ = Spot rate of the currency i two weekdays 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 weekday before the start of the current calendar month (or last weekday 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 weekday 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 $1005 \times (1 + 4.28\%) = 1048$ 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 weekday 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 weekday 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:

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

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 weekday 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 weekday of the month, in our example February 28, 2002.
- b) Check if today is the last weekday 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 weekday of the month. In our example, the last weekday 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

$$\begin{aligned}
 &= 1.5912 + 0.0003 * (16 / 28) \\
 &= 1.5912 + 0.00017 \\
 &= 1.59137
 \end{aligned}$$

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 INDEX²

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 Hedged 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 ADAPTIVE HEDGE INDEXES

4.1 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.

4.2 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.

4.3 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 weekdays 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 weekday of the previous month

4.3.1 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.

4.3.2 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 return⁴ 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.

4.3.3 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.

4.3.4 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.

APPENDIX: CUSTOM INDEXES WITH CASH ADJUSTMENT

DESCRIPTION

The MSCI Hedged Indexes and MSCI Adaptive Hedge Indexes, described in sections 2 and 4 respectively, can be customized to incorporate a cash component in the index calculation.

The cash amount is determined as of the close of the weekday prior to the last weekday of the month and is reflected in the index as of the close of the last weekday of the month. The cash amount is determined as a percentage of the value of the MSCI Hedged Index or MSCI Adaptive Hedge Index as of the close of the weekday prior to the last weekday of the month. The cash amount acts as a cash drag to the index performance as it reduces the value of both the equity and currency components of the index.

For example, if the cash percentage is set to 5%, the cash amount will correspond to 5% of the value of the MSCI Hedged Index or MSCI Adaptive Hedge Index as of the close of the weekday prior to the last weekday of the month, and the forward notional amount will correspond to 95% of the value of the MSCI Hedged Index or MSCI Adaptive Hedge Index as of the close of the weekday prior to the last weekday of the month.

The cash amount remains unchanged intra-month (no adjustments would be made to account for changes in the indexes due to price movement of securities or changes resulting from corporate events).

The custom indexes with cash adjustment can also incorporate a return on cash, calculated using one-month London InterBank Offered Rates (LIBOR) rates.

CALCULATION FORMULA – MSCI HEDGED INDEXES

The Hedge Impact for custom MSCI Hedged Indexes with cash adjustment is calculated as follows:

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

where

t = Index calculation date

$\%Cash(t)$ = Percentage of cash at time t . The percentage of cash is unchanged intra-month

NAF = Notional Adjustment Factor

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

M	see section 2.4
$HI(t)$	see section 2.4
$Weight_{i,M-2}$	see section 2.4
$FXRate_{i,M-2}$	see section 2.4
$FFRate_{i,M-1}$	see section 2.4
$FFRate_{i,odd-days_t}$	see sections 2.4 and 2.6

Performance of the Hedged Index =

$$\left(\frac{EquityIndex_t}{EquityIndex_{M-1}} - 1 \right) \times \left[\frac{HedgedIndex_{M-1} - (HedgedIndex_{M-2} \times \% \text{Cash}(t))}{HedgedIndex_{M-1}} \right] + HI(t) + (NAF \times \% \text{Cash}(t) \times \text{CashRet}(t))$$

where

$EquityIndex_t$ see section 2.4

$EquityIndex_{M-1}$ see section 2.4

$HedgedIndex_{M-1}$ = Value of the MSCI Hedged Index one weekday before the start of the current calendar month

$HedgedIndex_{M-2}$ = Value of the MSCI Hedged Index two weekdays before the start of the current calendar month

$\%Cash(t)$ = Percentage of cash at time t. The percentage of cash is unchanged intra-month

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

NAF = Notional Adjustment Factor as defined above

$CashRet(t)$ = Return on cash between the beginning of the month and the calculation date (t)

=

$$\left(\frac{days}{360} \times LIBOR(1M)_{M-1} \right)$$

$days$ = the number of calendar days since the beginning of the month (including day t)

$LIBOR(1M)_{M-1}$ = one-month London InterBank Offered Rates (LIBOR) rate one weekday before the start of the current calendar month. The source for LIBOR rates is the British Bankers' Association (BBA). The following LIBOR rates are currently available: USD, EUR, GBP, JPY, CHF

CALCULATION FORMULA – MSCI ADAPTIVE HEDGE INDEXES

The formula used for calculation of MSCI Adaptive Hedge Indexes with cash adjustment is same as specified above for MSCI Hedged Indexes with cash adjustment:

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

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 weekdays 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 weekday of the previous month

METHODOLOGY BOOK TRACKED CHANGES

The following sections have been modified since May 2011

- Sections 5.2.3 and 5.3.2

Update for currency weights being determined two weekdays 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

The following sections have been modified since July 2013

- Added a section on the MSCI Daily Hedged Indexes methodology

The following sections have been modified since November 2015

- Added a section on the MSCI Adaptive Hedge Indexes methodology

The following sections have been modified since September 2017:

- Moved the MSCI FX Hedge and MSCI Global Currency Indexes methodologies to a separate methodology book
- Section 1.1.4
Clarified the treatment of currency crisis

The following sections have been modified since October 2017:

- Added an appendix on custom indexes with cash adjustment

The following sections have been modified since October 2018:

- Section 1.1.3
Update in treatment of missing forward rates

The following sections have been modified since November 2018:

- Replaced “business day” with “weekday” for clarity in all relevant sections

CONTACT US

clientservice@msci.com

AMERICAS

Americas	1 888 588 4567 *
Atlanta	+ 1 404 551 3212
Boston	+ 1 617 532 0920
Chicago	+ 1 312 675 0545
Monterrey	+ 52 81 1253 4020
New York	+ 1 212 804 3901
San Francisco	+ 1 415 836 8800
Sao Paulo	+ 55 11 3706 1360
Toronto	+ 1 416 628 1007

EUROPE, MIDDLE EAST & AFRICA

Cape Town	+ 27 21 673 0100
Frankfurt	+ 49 69 133 859 00
Geneva	+ 41 22 817 9777
London	+ 44 20 7618 2222
Milan	+ 39 02 5849 0415
Paris	0800 91 59 17 *

ASIA PACIFIC

China North	10800 852 1032 *
China South	10800 152 1032 *
Hong Kong	+ 852 2844 9333
Mumbai	+ 91 22 6784 9160
Seoul	00798 8521 3392 *
Singapore	800 852 3749 *
Sydney	+ 61 2 9033 9333
Taipei	008 0112 7513 *
Thailand	0018 0015 6207 7181 *
Tokyo	+ 81 3 5290 1555

ABOUT MSCI

For more than 40 years, MSCI’s research-based indexes and analytics have helped the world’s leading investors build and manage better portfolios. Clients rely on our offerings for deeper insights into the drivers of performance and risk in their portfolios, broad asset class coverage and innovative research.

Our line of products and services includes indexes, analytical models, data, real estate benchmarks and ESG research.

MSCI serves 97 of the top 100 largest money managers, according to the most recent P&I ranking.

For more information, visit us at www.msci.com.

NOTICE AND DISCLAIMER

* = toll free

This document and all of the information contained in it, including without limitation all text, data, graphs, charts (collectively, the “Information”) is the property of MSCI Inc. or its subsidiaries (collectively, “MSCI”), or MSCI’s licensors, direct or indirect suppliers or any third party involved in making or compiling any Information (collectively, with MSCI, the “Information Providers”) and is provided for informational purposes only. The Information may not be modified, reverse-engineered, reproduced or disseminated in whole or in part without prior written permission from MSCI.

The Information may not be used to create derivative works or to verify or correct other data or information. For example (but without limitation), the Information may not be used to create indexes, databases, risk models, analytics, software, or in connection with the issuing, offering, sponsoring, managing or marketing of any securities, portfolios, financial products or other investment vehicles utilizing or based on, linked to, tracking or otherwise derived from the Information or any other MSCI data, information, products or services.

The user of the Information assumes the entire risk of any use it may make or permit to be made of the Information. NONE OF THE INFORMATION PROVIDERS MAKES ANY EXPRESS OR IMPLIED WARRANTIES OR REPRESENTATIONS WITH RESPECT TO THE INFORMATION (OR THE RESULTS TO BE OBTAINED BY THE USE THEREOF), AND TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, EACH INFORMATION PROVIDER EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES (INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF ORIGINALITY, ACCURACY, TIMELINESS, NON-INFRINGEMENT, COMPLETENESS, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY OF THE INFORMATION.

Without limiting any of the foregoing and to the maximum extent permitted by applicable law, in no event shall any Information Provider have any liability regarding any of the Information for any direct, indirect, special, punitive, consequential (including lost profits) or any other damages even if notified of the possibility of such damages. The foregoing shall not exclude or limit any liability that may not by applicable law be excluded or limited, including without limitation (as applicable), any liability for death or personal injury to the extent that such injury results from the negligence or willful default of itself, its servants, agents or sub-contractors.

Information containing any historical information, data or analysis should not be taken as an indication or guarantee of any future performance, analysis, forecast or prediction. Past performance does not guarantee future results.

The Information should not be relied on and is not a substitute for the skill, judgment and experience of the user, its management, employees, advisors and/or clients when making investment and other business decisions. All Information is impersonal and not tailored to the needs of any person, entity or group of persons.

None of the Information constitutes an offer to sell (or a solicitation of an offer to buy), any security, financial product or other investment vehicle or any trading strategy.

It is not possible to invest directly in an index. Exposure to an asset class or trading strategy or other category represented by an index is only available through third party investable instruments (if any) based on that index. MSCI does not issue, sponsor, endorse, market, offer, review or otherwise express any opinion regarding any fund, ETF, derivative or other security, investment, financial product or trading strategy that is based on, linked to or seeks to provide an investment return related to the performance of any MSCI index (collectively, “Index Linked Investments”). MSCI makes no assurance that any Index Linked Investments will accurately track index performance or provide positive investment returns. MSCI Inc. is not an investment adviser or fiduciary and MSCI makes no representation regarding the advisability of investing in any Index Linked Investments.

Index returns do not represent the results of actual trading of investable assets/securities. MSCI maintains and calculates indexes, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the index or Index Linked Investments. The imposition of these fees and charges would cause the performance of an Index Linked Investment to be different than the MSCI index performance.

The Information may contain back tested data. Back-tested performance is not actual performance, but is hypothetical. There are frequently material differences between back tested performance results and actual results subsequently achieved by any investment strategy.

Constituents of MSCI equity indexes are listed companies, which are included in or excluded from the indexes according to the application of the relevant index methodologies. Accordingly, constituents in MSCI equity indexes may include MSCI Inc., clients of MSCI or suppliers to MSCI. Inclusion of a security within an MSCI index is not a recommendation by MSCI to buy, sell, or hold such security, nor is it considered to be investment advice.

Data and information produced by various affiliates of MSCI Inc., including MSCI ESG Research LLC and Barra LLC, may be used in calculating certain MSCI indexes. More information can be found in the relevant index methodologies on www.msci.com.

MSCI receives compensation in connection with licensing its indexes to third parties. MSCI Inc.’s revenue includes fees based on assets in Index Linked Investments. Information can be found in MSCI Inc.’s company filings on the Investor Relations section of www.msci.com.

MSCI ESG Research LLC is a Registered Investment Adviser under the Investment Advisers Act of 1940 and a subsidiary of MSCI Inc. Except with respect to any applicable products or services from MSCI ESG Research, neither MSCI nor any of its products or services recommends, endorses, approves or otherwise expresses any opinion regarding any issuer, securities, financial products or instruments or trading strategies and MSCI’s products or services are not intended to constitute investment advice or a recommendation to make (or refrain from making) any kind of investment decision and may not be relied on as such. Issuers mentioned or included in any MSCI ESG Research materials may include MSCI Inc., clients of MSCI or suppliers to MSCI, and may also purchase research or other products or services from MSCI ESG Research. MSCI ESG Research materials, including materials utilized in any MSCI ESG Indexes or other products, have not been submitted to, nor received approval from, the United States Securities and Exchange Commission or any other regulatory body.

Any use of or access to products, services or information of MSCI requires a license from MSCI. MSCI, Barra, RiskMetrics, IPD, FEA, InvestorForce, and other MSCI brands and product names are the trademarks, service marks, or registered trademarks of MSCI or its subsidiaries in the United States

and other jurisdictions. The Global Industry Classification Standard (GICS) was developed by and is the exclusive property of MSCI and Standard & Poor's. "Global Industry Classification Standard (GICS)" is a service mark of MSCI and Standard & Poor's.