

June 9, 2020

INDEXES REPORTED IN FOREIGN CURRENCIES

CRSP reports the performance of selected index series in foreign currencies. In all cases the constituents of these indexes are the same as an underlying index, but the result is on the basis of the new currency.

There are two methods of measuring the value of an index against a foreign currency.

- A Hedged index is an investable method where a forward contract is used to hedge against fluctuations in the exchange rate.
- A Non-Hedged index is a direct snapshot based on the exchange rate each day.

The Hedged and Non-Hedged indexes supported are shown in the following table.

Index ID	Index Series Name	Index Symbol	Index CUSIP	Index FIGI	Currency (ISO)	Type	Underlying Index Constituents	Underlying Index Series	Rate Time
1001625	CRSP US Total Market Index (CAD-hedged) (TR)	CRSPTCHT	12630Y108	BBG003PZ7F52	CAD	Hedged	CRSP US Total Market Index	CRSP US Total Market Index Tax-Adjusted (TR)	London Close
	CRSP US Total Market Index (CAD-hedged) (PR)	CRSPTCH1	12628G200	BBG003PZ7F34				CRSP US Total Market Index (PR)	
1001617	CRSP US Total Market Index (AUD-hedged) (TR)	CRSPTAHT	12633D200	BBG009J9GN20	AUD	Hedged	CRSP US Total Market Index	CRSP US Total Market Index (TR)	London Close
	CRSP US Total Market Index (AUD-hedged) (PR)	CRSPTAH1	12633D101	BBG009J9GN11				CRSP US Total Market Index (PR)	
1001626	CRSP US Total Market Total Return Index CAD (TR)	CRSPTMCT	12632P204	BBG004MFW5W1	CAD	Non-Hedged	CRSP US Total Market Index	CRSP US Total Market Index Tax-Adjusted (TR)	New York Close
	CRSP US Total Market Index CAD (PR)	CRSPTMC1	12632M201	BBG004MFW5V2				CRSP US Total Market Index (PR)	
1001618	CRSP US Total Market Total Return Index AUD (TR)	CRSPTMAT	12633D408	BBG009J9GN48	AUD	Non-Hedged	CRSP US Total Market Index	CRSP US Total Market Index (TR)	London Close
	CRSP US Total Market Index AUD (PR)	CRSPTMA1	12633D309	BBG009J9GN39				CRSP US Total Market Index (PR)	

NON-HEDGED INDEXES

CRSP Non-Hedged indexes provide benchmarks of the U.S. equity market in terms of foreign currencies. CRSP calculates the index by directly converting the index level each day using the appropriate exchange rate between the U.S. dollar and the target currency. The reported index level and the index return are in terms of the target currency.

CRSP uses the WM/Reuters Spot Rate reported at the appropriate time for the intended users of the index. If the WM/Reuters Spot Rate is missing, CRSP will use the previous business day's Spot Rate. The Spot Rate used is as quoted in foreign exchange markets, but converted if needed to the form of from-USD to-target currency. The midpoint of quotes is used.

Index Level Formula

CRSP calculates the index in foreign currencies on a daily basis. The level of the index is calculated by multiplying the index by the exchange rate between the US dollar and the foreign currency.

The daily index level is calculated as:

Equation 1:

$$TindC_t = S_t Tind_t$$

Where

$TindC_t$ the level of the underlying index series in the foreign currency at date t

S_t the Spot rate on date t , in terms of from-USD to-target currency

$Tind_t$ The Index level of the underlying index series at date t

Index Return

Daily index returns can be calculated from the index levels,

$$r_{TindC,t} = \frac{TindC_t}{TindC_{t-1}} - 1$$

Where

$r_{TindC,t}$ the return of the index in the foreign currency at date t

$TindC_t$ the level of the index in a foreign currency at date t

$TindC_{t-1}$ the level of the index in a foreign currency on the previous business day

EXAMPLES

Index Calculation Example

The following example illustrates how CRSP calculates the level and daily return for the CRSP US Total Market Index in Canadian Dollars. Only the relevant data are shown in the table below, and numbers are not shown in full precision.

	Spot Rate	US Total Market Index, Tind (\$)	US Total Market Index CAD, Tind (C\$)
2/6/2013	0.99675	1174.665	1170.847
2/7/2013	0.99785	1172.823	1170.301

On February 6 and 7, 2013, CRSP US Total Market Index levels are 1174.665 and 1172.823. And the 4 pm EST spot rates for the same dates are C\$ 0.99675/\$ and C\$ 0.99785/\$ correspondingly. Thus, the US Total Market Index in Canadian dollars are

$$1174.665 \times 0.99675 = 1170.847 \text{ for Feb. 06, 2013}$$

and

$$1172.823 \times 0.99785 = 1170.301 \text{ for Feb. 07, 2013}$$

and the daily return for Feb. 07, 2013 is

$$r_{Feb.07,2013} = \frac{1170.301}{1170.847} - 1 = -0.047\%$$

HEDGED INDEXES

CRSP provides hedged indexes for foreign investors who only want exposure to the U.S. equity market by hedging the foreign exchange risk between the US dollar and foreign currencies.

The construction of the hedged indexes closely mimics the hedging process in practice. WM/Reuters is CRSP's source for spot and forward rates. The hedged amount, or the size for the Forward contract, is defined as the end-of-day hedged index level at the second-to-last business day of the previous month. The amount hedged is kept constant for the month. If the WM/Reuters Spot rate and/or the Forward rate are missing, CRSP will use the previous business day's Spot and Forward rates. All rates used are as quoted in foreign exchange markets, but converted if needed in all formulas to the form of from-USD to-target currency. The midpoint of quotes is used.

The value of the index is driven by two parts: the amount tracking the underlying index and the value of the Forward contract. This is described in detail in the Formula section. The reported level of the index and also the index return are in terms of the foreign currencies

HEDGED INDEX FORMULA

Index Level

CRSP calculates the levels of the hedged indexes on a daily basis. The levels of the hedged indexes reflects the component that tracks the underlying index and the value of the Forward contract, the hedging part.

Within any month M , the daily Hedged index level is calculated as:

Equation 2:

$$Y_t = S_t \rho_0 T ind_t + \tilde{X}_0 \left[F_{0,T} - S_t - (F_{t,1-month} - S_t) \times \frac{RemD}{TD} \right]$$

Where:

Y_t the Hedged Index level in terms of the foreign currency at date t

S_t the Spot rate on date t , 4 pm UK closing Spot rate

ρ_0 the Hedged Level Multiplier for the month; constant for month M

$T ind_t$ The index level at date t

\tilde{X}_0 the hedged amount, the end-of-day hedged index level at the second-to-last business day of month $M-1$, in terms of U.S. dollars

$F_{0,T}$ the 4 pm UK closing one-month Forward rate at the last business day of month $M-1$

$F_{t,1-month}$ the 4 pm UK closing one-month Forward rate on date t

$RemD$ the remaining counted days till the last business day of the month (excluding day t)¹

TD the total number of counted days within the month

As shown in Equation 1, $S_t \rho_0 T ind_t$ tracks the performance of the underlying index and $\tilde{X}_0 \left[F_{0,T} - S_t - (F_{t,1-month} - S_t) \times \frac{RemD}{TD} \right]$ is the value of the Forward contract at date t . The term, $S_t + (F_{t,1-month} - S_t) \times \frac{RemD}{TD}$, marks to market the value of foreign currencies on the last business day of month M .

¹ Counted days include weekends and holidays. Or, in other words, every day counts.

Index Return

Daily index returns can be easily calculated from the index levels,

$$r_{Y,t} = \frac{Y_t}{Y_{t-1}} - 1$$

Where:

$r_{Y,t}$ the Hedged Index daily return at date t

Y_{t-1} the Hedged Index level in terms of the foreign currency at date $t-1$

INDEX MAINTENANCE

CRSP maintains the hedged indexes to closely reflect fund managers' hedging activities. CRSP resets the Hedged Level Multiplier (P_0) and the Hedged Amount (\tilde{X}_0) on a monthly basis, consistent with the fact that fund managers roll the Forward contract monthly. For each month, the Hedged Level Multiplier (P_0) is determined by the ratio between the end-of-day Hedged Index level in U.S. dollars and the index level on the last business day of the previous month. The Hedged Amount (\tilde{X}_0) is determined by end-of-day hedged index level, in U.S. dollars, on the second-to-last business day of the previous month.

EXAMPLES:

Index Calculation Example

The following example illustrates how the CRSP Canadian Hedged Index level and daily return was calculated. Only the relevant data are shown in the table below, and numbers are not shown in full precision. The same approach is used to calculate the CRSP Australian Hedged Index level and daily return.

	Spot Rate	Forward Rate 1 Month	Underlying US Total Market Index Tind(\$)	TD	RemD	CRSPTCHT (C\$)
1/30/2013	1.00290					1161.166
1/31/2013	0.99885	0.99945	1163.154			1159.429
2/6/2013						1171.030
2/7/2013	0.99785	0.99846	1172.823	28	21	

For February 2013, CRSP reset the HLM (P_0) and Hedged Amount (\tilde{X}_0) based on relevant information at the end of January 2013. At the close on January 31, 2013, the underlying U.S. Total Market Index level (\$) is 1163.154, the Canadian Hedged Index level is 1159.429, and the spot rate is C\$ 0.99885/\$. Thus, the HLM for February, 2013 is

$$\rho_0 = \frac{1159.429}{0.99885 \times 1163.154} = 0.9979$$

The Hedged amount,

$$\tilde{X}_0 = \frac{1161.166}{1.0029} = 1157.808$$

is the Canadian Hedged Index level on Jan. 30, 2013, in terms of US dollars.

Since the last day of the month, February 28, 2013 is a business day, there are 21 days left on the hedging Forward contract from Feb. 07, 2013. Thus, $RemD=21$.

Based on Equation 1, the Canadian Hedged Index level on Feb. 07, 2013 is

$$Y_{Feb.07,2013} = 0.99785 \times 0.9979 \times 1172.823 + 1157.808 \times \left[0.99945 - 0.99785 - (0.99846 - 0.99785) \frac{21}{28} \right] = 1169.167$$

And the daily return on Feb. 07, 2013 is

$$r_{Feb.07,2013} = \frac{1169.167}{1171.030} - 1 = -0.159\%$$

HEDGED AMOUNT AND FORWARD RATE EXAMPLES

Since fund managers roll the forward contract on the last business day of each month, the hedged amount \tilde{X}_0 is calculated based on the end-of-day level of the hedged index on the second-to-last business day before the beginning of the current month. And $F_{0,T}$ is taken as the 4 pm UK closing (11:00 am EST) Forward rate one business day before the beginning of the this month.

Several examples illustrate this process:

Example 1:

October 01, 2011 is a Saturday. The forward contract will be rolled on Friday, September 30, 2011. \tilde{X}_0 will be calculated based on the end-of-day hedged index level on September 29, 2011. And $F_{0,T}$ is taken as the 4 pm UK closing (11 am EST) 1-month forward rate on Friday, September 30, 2011.

Example 2:

July 01, 2012 is a Sunday. Since June 30, 2012 is a Saturday, the forward contract will be rolled on Friday, June 29, 2012. \tilde{X}_0 will be calculated based on the end-of-day hedged index level on June 28, 2012. And $F_{0,T}$ is taken as the 4 pm UK closing (11 am EST) 1-month forward rate on Friday, June 29, 2012.

Example 3:

May 01, 2012 is a Tuesday. The forward contract will be rolled on Monday, April 30, 2012. Since April 28 and 29 are Saturday and Sunday, \tilde{X}_0 will be calculated based on the end-of-day hedged index level on Friday, April 27, 2012. And $F_{0,T}$ is taken as the 4 pm UK closing (11 am EST) 1-month forward rate on Monday, April 30, 2012.

TAX-ADJUSTED INDEXES

An underlying index for a total return series may be tax-adjusted to represent the tax withholding on dividends imposed on foreign investors of securities held in the underlying index. All dividends paid are reduced by 15% when the index returns are calculated.

Index ID	Index Series Name	Index Symbol	Underlying Index Constituents	Rule to Estimate Withholdings	Withholding Rate
1001331	CRSP US Total Market Tax Adjusted Index (TR)	CRSPTTT	CRSP US Total Market Index	Reduce all cash dividends by the withholding rate	15%

TAX-ADJUSTED CRSP US TOTAL MARKET HEDGED TO CAD INDEX (TAX-ADJUSTED CANADIAN HEDGED INDEX)

There are two components in a Tax-Adjusted Canadian Hedged US index. The first follows the underlying US index withholding the Canadian tax rate on the daily bases and the second is the Forward contract for the hedging purpose.

The part following the underlying US index is at level X_{t-1} and X_t in dates $t-1$ and t (the corresponding daily return $X_t = X_{t-1}[1 + r_t - (r_t - r_a)r_{twh}]$, all in terms of US \$. And r_t is the CRSP US Total Market daily total return at day t , r_a is the CRSP US Total Market price return at day t and r_{twh} is the Canadian withholding tax rate, The forward contract is for selling the notional amount of \tilde{X}_0 US \$. The level of the Canadian Hedged US Index at day t can be expressed as:

$$S_t X_{t-1} [1 + r_t + (r_t - r_a)r_{twh}] + \tilde{X}_0 (F_{0,T} - \tilde{F}_{t,T})$$

where S_t is the spot rate at day t , $F_{0,T}$ is the day 0 forward rate maturity at date T, ² and $\tilde{F}_{t,T}$ is the day t forward rate at maturity at date T. $\tilde{F}_{t,T}$ is estimated by interpolating the one month forward rate on day t .

$$\tilde{F}_{t,T} = S_t + (F_{t,1-month} - S_t) \times \frac{RemD}{TD}$$

Where $F_{t,1-month}$ is the day t one-month forward rate, $RemD$ is the remaining counted days till the last business day of the month (excluding day t), TD is the total number of counted days within the month.³

Y and r_Y represent the level and daily return of the Tax Adjusted Canadian Hedged US Index in terms of Canadian \$. The related calculation is summarized in the following table:

TABLE 1 THE TAX ADJUSTED CANADIAN HEDGED US INDEX

Index	Unhedged part following US Index (US \$)		Canadian Hedged US Index (Canadian \$)	
Time	t-1	t	t-1	t
Level	X_{t-1}	X_t	Y_{t-1}	$Y_t = S_t X_t + \tilde{X}_0 (F_{0,T} - \tilde{F}_{t,T})$
Index Daily Return	r_{t-1}	r_t	$r_{Y,t-1}$	$r_{Y,t} = \frac{Y_t}{Y_{t-1}} - 1$

² All exchange rates are quoted in term of C\$/\$, which is the amount of Canadian dollar(C\$) per 1 US dollar(\$)

³ Counted days include weekends and holidays. Or, in other words, everyday counts.

Since fund managers rolling the forward contract by the end of the month, \tilde{X}_0 is taken as the end-of-day level of the hedged index two business days before the beginning of this month. And $F_{0,T}$ is taken as the 11:00 a.m. EST forward rate one business day before the beginning of the this month.

Several examples illustrate this process:

Example 1:

October 01, 2011 is a Saturday. The forward contract will be rolled on Friday, September 30, 2011. \tilde{X}_0 will be the end-of-day hedged index level⁴ on September 29, 2011. And $F_{0,T}$ is taken as the 11 am EST 1-month forward rate on Friday, September 30, 2011.

Example 2:

July 01, 2012 is a Sunday. Since June 30, 2012 is a Saturday, the forward contract will be rolled on Friday, June 29, 2012. \tilde{X}_0 will be the end-of-day hedged index level on June 28, 2012. And $F_{0,T}$ is taken as the 11 am EST 1-month forward rate on Friday, June 29, 2012.

Example 3:

May 01, 2012 is a Tuesday. The forward contract will be rolled on Monday, April 30, 2012. Since April 28 and 29 are Saturday and Sunday, \tilde{X}_0 will be the end-of-day hedged index level on Friday, April 27, 2012. And $F_{0,T}$ is taken as the 11 am EST 1-month forward rate on Monday, April 30, 2012.

⁴ In terms of US \$

ABOUT THE CRSP INDEXES

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For further information please refer to the CRSP website, and to the CRSP Index Methodology Guide posted [here](#).
For any related inquiry, please email Indexes@crsp.org or call 312-263-6400, option 3.
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