

Calculation examples for inflation-linked bonds

Below are examples of calculations for inflation-linked bonds. The examples are based on the document "Calculation principles for the Swedish Money- and Bond market" from the Swedish Securities Dealers Association on April 2, 2001. The following five points are dealt with in the calculation examples:

1. The index factor
2. The coupon amount for an inflation-linked coupon bond
3. The redemption amount at maturity
4. The settlement amount for an inflation-linked coupon bond
5. The settlement amount for an inflation-linked zero coupon bond

1. The index factor

The index factor is used in order to adjust the cash flows of an inflation-linked bond for inflation. The index factor expresses the change in the Swedish consumer price index (CPI), i.e. the change in the price level between two dates. The index factor is calculated as the ratio between the "reference index" (the reference CPI for a given date) and the base index for the bond (a historical CPI index). The base index is determined when the bond is introduced and never changes. The reference index is the CPI that is applicable on a given date. For each day, a specific reference index is applicable.

The CPI is updated by Statistics Sweden once a month and is published in the middle of the following month. For example, the CPI for August is published in mid-September. The reference index for the first day of every month is equal to the CPI three months earlier. The reference index for all other days in the month is calculated by linear interpolation between the two adjacent CPI indices. A lag of three months for the reference index is necessary, since two adjacent CPI numbers are needed to enable interpolation.

When calculating the index factor, all months are assumed to have 30 days. If the settlement day is the 31st, the day number in the formula below is set at 30. However, if the settlement day is February 28, it is counted as the 28th and not as the 30th.

Example

Bond: 3104

Trade date: August 21, 2017

Settlement date*: August 23, 2017 (*day = 23*)

Reference index for August 1, 2017: 321.74 (CPI May 2017)

Reference index for September 1, 2017: 321.97 (CPI June 2017)

Base index: 256.2 (CPI January 1999)

$$\text{Index factor}_{\text{Aug23,2017}} = \frac{\text{Ref. index}_{\text{Aug23,2017}}}{\text{Base index}}$$

* Settlement occurs two business days after the trade date.

$$= \frac{\text{Ref. index}_{\text{Aug1,2017}} + \frac{\text{day}-1}{30} \times (\text{Ref. index}_{\text{Sep1,2017}} - \text{Ref. index}_{\text{Aug1,2017}})}{\text{Base index}}$$

$$= \frac{321.74 + \frac{23-1}{30} \times (321.98 - 321.74)}{256.2} = 1.256474 \dots$$

2. The coupon amount for an inflation-linked coupon bond

The coupon amount to be disbursed on the coupon day is calculated by multiplying the index factor by the real coupon. This gives us the nominal coupon. It is rounded off to five decimal points (expressed in percentage) and is then multiplied by the face value.

Example

Bond: 3104

Real coupon: 3.5 %

Coupon date: December 1, 2016

Reference index for December 1, 2016: 316.91 (CPI September 2016)

Base index: 256.2

Face value: SEK 100 M

$$\text{Nominal coupon}_{\text{Dec 1, 2016}} = \text{Real coupon} \times \text{Index factor}_{\text{Dec1, 2016}}$$

$$= 0.035 \times \frac{316.91}{256.2} = 0.0432937 \dots$$

$$\text{Coupon amount}_{\text{Dec 1, 2016}} = \text{Round}[\text{Nominal coupon}_{\text{Dec 1, 2016}}; 7] \times \text{Face value}$$

$$= 0,0432937 \times \text{SEK } 100 \text{ M} = 4,329,370$$

3. The redemption amount at maturity

The amount to be disbursed on the maturity date (excluding the last coupon) is calculated by multiplying the face value by the index factor. All loans except 3102 have deflation protection, which means that the index factor on the maturity date cannot be less than 1.

For loans without deflation protection (loan 3102) the following applies:

$$\text{Redemption amount} = \text{Face value} \times \frac{\text{Reference index at maturity}}{\text{Base index}}$$

For loans with deflation protection the following applies:

$$\text{Redemption amount} = \text{Face value} \times \max\left[\frac{\text{Reference index at maturity}}{\text{Base index}}; 1\right]$$

4. The Settlement amount for an inflation-linked coupon bond

In order to calculate the settlement amount, we first calculate the price. That is done by multiplying the index factor by the sum of all future real cash flows discounted by the real yield. Based on this price, we calculate the clean price by subtracting the accrued interest and rounding off the result to three decimal points. The settlement amount is calculated by adding back the accrued interest on the clean price and then multiplying by the face value. The settlement amount is rounded off to the nearest krona.

Example

Bond: 3104

Real coupon: 3.5 %

Trade date: August 21, 2017

Settlement date*: August 23, 2017

Maturity date: December 1, 2028

Day-count convention: 30E/360

Number of days to next coupon, $d = 98$

Number of years to maturity from next coupon date, $n = 11$

Real yield, $y = -1.125\%$

Face value: SEK 100 M

$$\begin{aligned} \text{Price}^{**} &= \text{Index factor}_{\text{Aug23,2017}} \times \left[\frac{\text{Real coupon in SEK}}{(1+y)^{d/360}} + \frac{\text{Real coupon in SEK}}{(1+y)^{d/360+1}} + \dots + \frac{\text{Nom. amount + Real coupon in SEK}}{(1+y)^{d/360+n}} \right] \\ &= 1.256474 \dots \times \left[\frac{3.5}{(1+(-0.01125))^{98/360}} + \frac{3.5}{(1+(-0.01125))^{98/360+1}} + \dots + \frac{100 + 3.5}{(1+(-0.01125))^{98/360+11}} \right] \\ &= 199.114218 \dots \end{aligned}$$

$$\begin{aligned} \text{Accrued interest} &= \text{Index factor}_{\text{Aug23,2017}} \times \frac{360-d}{360} \times \text{Real coupon in SEK} \\ &= 1.256474 \dots \times \frac{360-98}{360} \times 3.5 = 3.200518 \dots \end{aligned}$$

$$\begin{aligned} \text{Clean price} &= \text{Round} [\text{Price} - \text{Accrued interest}; 3] \\ &= 199.114218 \dots - 3.200518 \dots = 195.914 \end{aligned}$$

$$\text{Settlement amount} = \text{Round} \left[(\text{Clean price} + \text{Accrued interest}) \times \frac{\text{Face value}}{100}; 0 \right]$$

* Settlement occurs two business days after the trade date.

$$= (195.914 + 3.200518 \dots) \times \frac{\text{SEK } 100 \text{ M}}{100} = 199 \ 114 \ 519$$