Learning Module 10: Interest Rate Risk and Return

Fixed Income

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Duration Gap

$$\text{Duration gap} = \text{Macaulay duration} - \text{Investment horizon}$$

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### Duration Gap

$$
\text{Duration gap} = \text{Macaulay duration - Investment horizon}
$$
```

Macaulay Duration

The general calculation of Macaulay duration, $MacDur$, that also accounts for partial coupon periods if the calculation is done between coupon dates is shown in Equation 2.

$$MacDur = \left\{ \begin{aligned} (1 - t/T)\left[\frac{\frac{PMT}{(1+r)^{1-t/T}}}{PV^{Full}}\right] + (2 - t/T)\left[\frac{\frac{PMT}{(1+r)^{2-t/T}}}{PV^{Full}}\right] + \\ \cdots + (N - t/T)\left[\frac{\frac{PMT+FV}{(1+r)^{N-t/T}}}{PV^{Full}}\right] \end{aligned} \right\} \tag{2}$$

Where:

- t is the number of days from the last coupon payment to the settlement date
- T is the number of days in the coupon period
- t/T is the fraction of the coupon period that has passed since the last payment
- PMT is the coupon payment per period
- FV is the future value paid at maturity, or the par value of the bond
- r is the yield-to-maturity per period; and
- N is the number of evenly spaced periods to maturity as of the beginning of the current period

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### Macaulay Duration

The general calculation of Macaulay duration, $MacDur$, that also accounts for partial coupon periods

$$
MacDur =
\left\{
\begin{aligned}
(1 - t/T)\left[\frac{\frac{PMT}{(1+r)^{1-t/T}}}{PV^{Full}}\right]
+
(2 - t/T)\left[\frac{\frac{PMT}{(1+r)^{2-t/T}}}{PV^{Full}}\right]
```

```
+ \\
\cdots +
(N - t/T)\left[\frac{\frac{PMT + FV}{(1+r)^{N-t/T}}}{PV^{Full}}\right]
\end{aligned}
\right\} \tag{2}
$$

Where:

- $t$ is the number of days from the last coupon payment to the settlement
  date
- $T$ is the number of days in the coupon period
- $t/T$ is the fraction of the coupon period that has passed since the last
  payment
- $PMT$ is the coupon payment per period
- $FV$ is the future value paid at maturity, or the par value of the bond
- $r$ is the yield-to-maturity per period; and
- $N$ is the number of evenly spaced periods to maturity as of the beginning
  of the current period
```

Macaulay Duration: Closed-Form

$$MacDur = \left\{ \frac{1+r}{r} - \frac{1+r+[N \times (c-r)]}{c \times [(1+r)^N - 1] + r} \right\} - \frac{t}{T} \tag{3}$$

Where:

- r is the yield-to-maturity per period
- N is the number of evenly spaced periods to maturity as of the beginning of the current period
- c is the coupon rate per period
- t is the number of days from the last coupon payment to the settlement date and
- T is the number of days in the coupon period

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### Macaulay Duration: Closed-Form

$$
MacDur =
\left\{
\frac{1+r}{r}
-
\frac{1 + r + [N \times (c - r)]}{c \times \left[(1+r)^N - 1\right] + r}
\right\}
-
\frac{t}{T} \tag{3}
$$

Where:

- $r$ is the yield-to-maturity per period
- $N$ is the number of evenly spaced periods to maturity as of the beginning
  of the current period
- $c$ is the coupon rate per period
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