# Hello to Mr. Macaulay!

Recently, SEBI has proposed fixed income product rationalisation based on Macaulay Duration. This note gives a refresher of Macaulay Duration and other related terms and their use.

## What is Duration?

Price of any fixed income instrument is determined by summing the expected cash flows of the instrument and discounting it by a rate of return. Thus, for a bond portfolio, the sensitivity of a bond to changes in the yield is a key metric. This metric influences how the portfolio will react to changes in the interest rate environment.

Higher the duration, higher is the sensitivity to change in interest rates and vice versa. For instance, a bond with a higher duration will have a greater positive impact on its return if there is a fall in interest rates versus, a bond with a lower duration.

Two most commonly used measures of Duration are Macualay and Modified Duration.

## Macualay Duration

The formula usually used to calculate a bond's basic duration is the Macaulay duration, which was created by Frederick Macaulay in 1938, although it was not commonly used until the 1970s.

The Macaulay duration calculates weighted average number of years an investor must stay invested in the bond to break even (please refer the graphical representation below).



HSBC
**Global Asset Management**
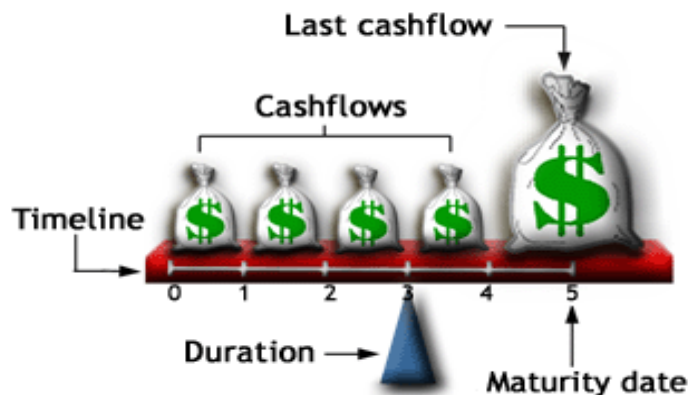
Mathematically, it is the time-weighted Present Value of cash flows divided by the market price of the bond (Refer Annex 1 for the formula of Macualay duration).

Refer the following example to understand how Macaulay duration is calculated for a bond with 8% coupon, 7.5% YTM (Yield to Maturity) and 5 years to maturity.

| YTM | 7.50% | Coupon | 8% |
|---|---|---|---|
| Principal | 1000 | | |
| Time period | Cash Flow | DCF | DCF * Time Period |
| 1 | 75 | 69.8 | 69.8 |
| 2 | 75 | 64.9 | 129.8 |
| 3 | 75 | 60.4 | 181.1 |
| 4 | 75 | 56.2 | 224.6 |
| 5 | 1075 | 748.8 | 3744.0 |
| | Sum --> | 1000.0 | 4349.3 |
| | | | 4.35 |

<--- Macaulay Duration

## Modified Duration

Modified duration is an extension of Macaulay's duration wherein it measures the price sensitivity of the bond for a change in yield to maturity (or change in interest rates).

For instance, if the price of a bond changes by 1% for a 20 bps change in yield to maturity, then its modified duration equals 100 bps/20 bps= 5.

**Comparison between Modified and Macualay Duration**

Modified duration of a bond will always be lower than or equal to Macaulay duration of a bond which in turn is lower than or equal to the residual maturity of the bond. As can be noticed from the graphs, both values will change with time to maturity or with the coupon rate, for the same yield to maturity.



Macualay & modified duration for a bond with a YTM of 8% and 10 years to maturity
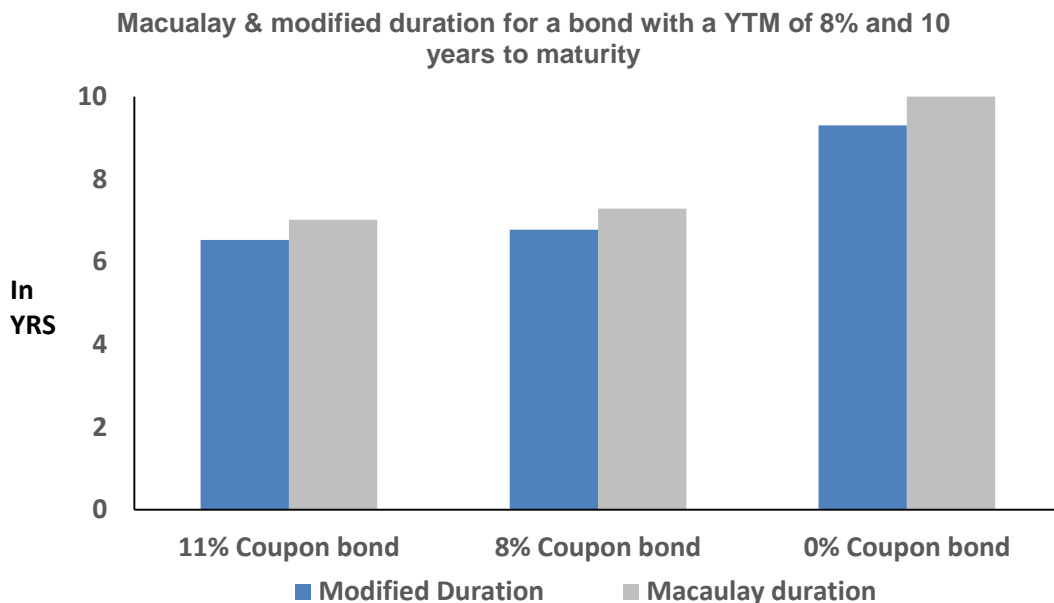
**As can be seen from the first graph,**

- The Macualay duration of a zero-coupon bond equals its maturity. Further for two bonds with same time to maturity,
- Higher the coupon rate, lower will be the Macualay and modified durations
- Similarly, for the same coupon, a larger time to maturity implies a higher Macualay and modified duration

**Macualay & Modified duration for a bond with a YTM of 8% and coupon of 7.5%**
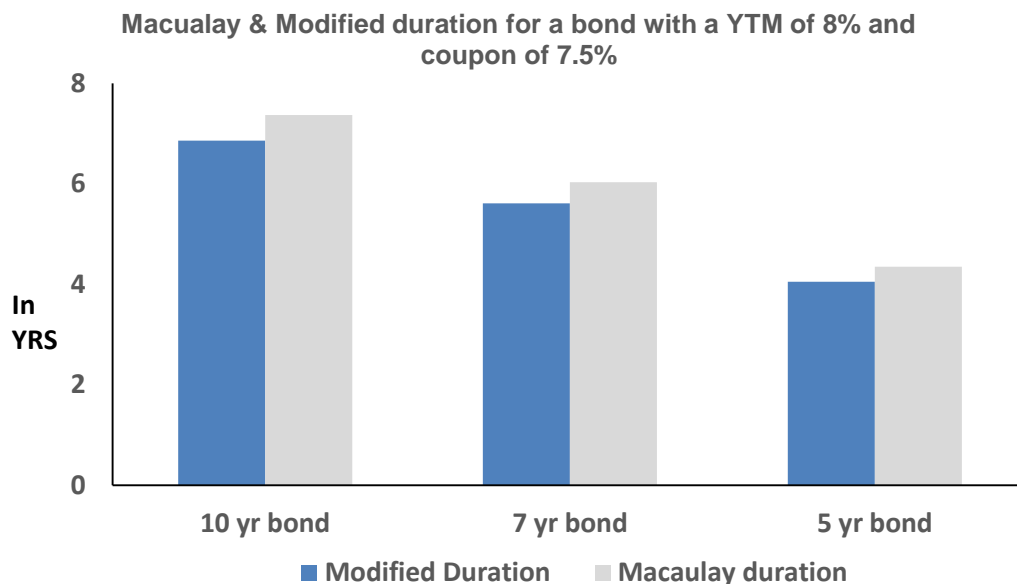


**Uses of Modified Duration**

Generally, modified duration is used in fixed income investing

- to measure the sensitivity of a bond or a portfolio to interest rate changes
- investor can compare interest rate risk in the portfolio by measuring against modified duration

For example, a portfolio with a modified duration of 4 years will be twice as sensitive to interest rates as a portfolio with modified duration of 2 years.

**Uses of Macaulay Duration**

Macaulay duration is useful in

- choosing the right fund based on investment horizon of the investor.
- Macaulay duration of a fund gives an indication of the relative balance of interest rate risk and re-investment risks

For example:

- If a portfolio's Macaulay's duration is greater than an investor's investment horizon the portfolio will add interest rate risk (and reduce reinvestment risk) for the investor.
- If the duration of the portfolio is shorter than the investor's investment horizon the portfolio will add reinvestment risk (and reduce interest rate risk).
- Investors should look to match the Macaulay duration with their investment horizon.

Annexure 1

The formula for Macaulay duration is:

$$\text{Macaulay duration} = \frac{\sum\limits_{t=1}^{n} \dfrac{tC}{(1+y)^t} + \dfrac{nM}{(1+y)^n}}{P}$$

Where:

      t = period in which the coupon is received

      C = periodic (usually semiannual) coupon payment

      y = the periodic yield to maturity

      n = number of periods

      M = maturity value

      P = market price of bond

**Mathematically it can be shown that Modified Duration equals**

$$\text{Modified Duration} = \left[ \frac{\text{Macauley Duration}}{\left(1 + \dfrac{\text{YTM}}{n}\right)} \right]$$

**Mutual Fund investments are subject to market risks, read all scheme related documents carefully.**

HSBC Asset Management (India) Private Limited, 16, V.N. Road, Fort, Mumbai-400001 Email: hsbcmf@camsonline.com

▶ www.assetmanagement.hsbc.com/in