☆ Convexity?

① coupon bond = $\sum$ zero-coupon bond

⇒ Convexity = $\sum W_i \cdot$ Convexity of each zero-coupon bond

W_i = Present Value / Total Price

$P_0 = \frac{C}{1+y}$ ⇒ period t,

Convexity = $\frac{t(1+t)}{(1+y)^2}$

② Approximate convexity

$$= \frac{P_+ + P_- - 2P_0}{(\Delta y)^2 P_0}$$

$$\Rightarrow \frac{\Delta P}{P} = -MD \times \Delta y + \frac{1}{2}(\Delta y)^2 \cdot \text{convexity}$$

$$\Rightarrow \Delta P = -\underbrace{MD \times P}_{\text{Money Duration}} \times \Delta y + \frac{1}{2}(\Delta y)^2 \cdot \underbrace{\text{convexity} \cdot P}_{\text{Money Convexity}}$$

☆ How to estimate Portfolio's duration and convexity

① Theoretical Approach ⇒ Check all cash flows and discount

⇒ Impossible as y for each date cannot be induced

② Portfolio Duration = $\sum W_i D_i$

W_i = Each Bond Price / Full price of portfolio

Assumption: Each bond YTM should be changed by the same amount (parallel shift)

semi-annual convexity $/ 2^2$ ⇒ Annualized Convexity

I/Y = 0.05

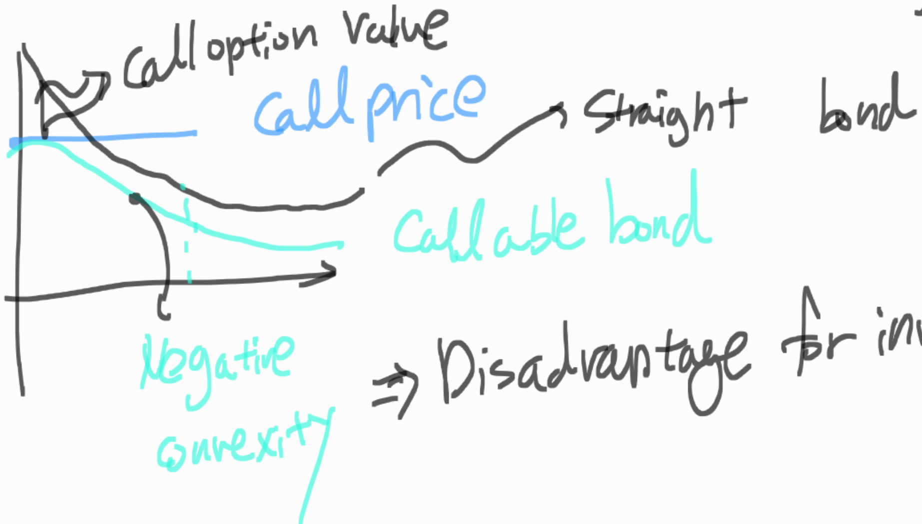
4% 103.629

96.53489

☆ Bonds with Options, MBS... ⇒ Can't determine yield

⇒ Calculate duration/convexity based on "benchmark" yield

⇒ Effective duration $\dfrac{P^{+} - P^{-}}{2 \cdot \Delta r_f \cdot P_0}$



⇒ Disadvantage for investors

☆ Key rate duration / partial duration $D_{P/F} = \dfrac{\Delta}{2 P_0 \, \Delta \underbrace{rf_1}_{\text{1 year US bond}}}$

☆ ... Empirical duration.....