

FinQuiz Formula Sheet CFA Program Level III

VOLUME 1: ASSET ALLOCATION

Learning Module 1:

Capital Market Expectations, Part 1: Framework and Macro Considerations

1. Aggregate Market Value of Equity:

$$V_t^e = \text{GDP}_t \times S_t^k \times \text{PE}_t$$

Where,

- GDP is a level of nominal GDP
- S_t^k is the share of profits in the economy
- PE_t is the P/E ratio.

2. Taylor Rule:

$$i^* = r_{\text{neutral}} + \pi_e + 0.5 \times (\hat{Y}_e - \hat{Y}_{\text{trend}}) + 0.5 \times (\pi_e - \pi_{\text{target}})$$

Where,

i^* = target nominal policy rate
 r_{neutral} = real policy rate that would be targeted if GDP growth were on trend & inflation on target

$\pi_e, \pi_{\text{target}}$ = respectively the expected and target inflation rates

$\hat{Y}_e, \hat{Y}_{\text{trend}}$ = respectively the expected and trend real GDP growth rates

By readjusting the above equation:

3. Real inflation adjusted target rate

$$i^* - \pi_e = r_{\text{neutral}} + 0.5 \times (\hat{Y}_e - \hat{Y}_{\text{trend}}) + 0.5 \times (\pi_e - \pi_{\text{target}})$$

4. Net exports:

= Net Private Savings + Government Surplus

$$(X-M) = (S-I) + (T-G)$$

5. Government Surplus:

= Taxes - Government spending

Learning Module 2

Capital Market Expectations, Part 2: Forecasting Asset Class Returns

1. Expected Rate of Return On Equity $E(R_e)$:

$$E(R_e) \approx \frac{D}{P} + (\% \Delta E - \% \Delta S) + \Delta P/E$$

Where,

- $E(R_e)$ = Expected rate of return on equity
- D/P = Expected dividend yield
- $\% \Delta S$ = Expected % change in number of shares outstanding

2. Under Basic CAPM model

$$a) RP_i = \beta_{i,M} RP_M$$

$$b) \beta_{i,M} = \text{Cov}(R_i, R_M) / \sigma_M^2 = \rho_{i,M} \left(\frac{\sigma_i}{\sigma_M} \right)$$

Where,

$RP_i = [ER_i - R_F]$ risk premium on i th asset

$RP_M = [ER_M - R_F]$ risk premium on market portfolio

$\beta_{i,M}$ = i th asset sensitivity to market

$$\text{portfolio} = \frac{\text{Cov}(R_i, R_M)}{\sigma_M^2} = \rho_{i,M} \left(\frac{\sigma_i}{\sigma_M} \right)$$

σ is standard deviation and ρ is correlation

3. Expected Return using Singer-Terhaar Model:

Model's 1st component (full integration assumption):

$$4. RP_i^G = \beta_{i,GM} RP_{GM} = \rho_{i,GM} \sigma_i \left(\frac{RP_{GM}}{\sigma_{GM}} \right)$$

Model's 2nd component (completely segmented market assumption):

$$5. RP_i^S = 1 \times RP_{GM} = 1 \times \sigma_i \left(\frac{RP_i^S}{\sigma_i} \right)$$

$$6. RP_i = \phi RP_i^G + (1 - \phi) RP_i^S$$

$$7. \text{Cap rate} = \frac{\text{Current year's NOI}}{\text{Property value}}$$

where NOI = net operating Income

8. $E(R_{re})$ = Expected return on real estate

- *long run* (assuming constant growth rate for NOI) is:

$$E(R_{re}) = \text{Cap rate} + \text{NOI growth rate}$$

- for a *finite horizon* (to reflect expected rate of change in the cap rate) is:

$$E(R_{re}) = \text{Cap rate} + \text{NOI growth rate} - \% \Delta \text{Cap rate}$$

9. Implication of capital mobility:

$$E(\% \Delta S_{d/f}) = (r^d - r^f) + (\text{Term}^d - \text{Term}^f) + (\text{Credit}^d - \text{Credit}^f) +$$

$$(\text{Equity}^d - \text{Equity}^f) + (\text{Liquid}^d - \text{Liquid}^f)$$

$$10. r_i = \alpha_i + \sum_{k=1}^K \beta_{ik} F_k + \varepsilon_i$$

r_i = return on *i*th asset

α_i = constant intercept

β_{ik} = asset's sensitivity to *k*th factor

F_k = *k*th common factor return

ε_i = error term

11. Variance on *i*th asset

$$= \sigma_i^2 = \sum_{m=1}^K \sum_{n=1}^K \beta_{im} \beta_{jn} \rho_{mn} + v_i^2$$

where,

ρ_{mn} = covariance between the *m*th and *n*th factor

v_i^2 = variance of *i*th asset return

12. Covariance between *i*th and *j*th

$$= \sigma_{ij} = \sum_{m=1}^K \sum_{n=1}^K \beta_{im} \beta_{jn} \rho_{mn}$$

13. Current return

$$= R_t = (1 - \lambda)r_t + \lambda R_{t-1}$$

where λ may range from 0 to 1

$$14. \text{var}(r) = \left(\frac{1+\lambda}{1-\lambda} \right) \text{var}(R) > \text{var}(R)$$

15. ARCH Methodology

$$\sigma_t^2 = \gamma + \alpha \sigma_{t-1}^2 + \beta \eta_t^2$$

Rearranging the above equation:

$$\sigma_t^2 = \gamma + (\alpha + \beta) \sigma_{t-1}^2 + \beta (\eta_t^2 - \sigma_{t-1}^2)$$

Learning Module 3 Overview of Asset Allocation

1. Risky Asset Allocation

$$= w^* = \frac{1}{\lambda} \left[\frac{\mu - r_f}{\sigma^2} \right]$$

Learning Module 4 Principles of Asset Allocation

1. Investor's Utility for Asset Mix

$$U_m = E(R_m) - 0.005 \lambda \sigma_m^2$$

2. Risk Parity

$$w_i \times \text{Cov}(r_i, r_p) = \frac{1}{n} \sigma_p^2$$

3. Marginal contribution to risk ($MCTR_i$)

$$= (\text{Beta of Asset Class } i \text{ relative to Portfolio}) \times (\text{Portfolio Std. Dev.})$$

4. Absolute contribution to risk ($ACTR_i$)

$$= \text{Asset class weight}_i \times MCTR_i$$

5. Portfolio Std. Dev. (expected)

$$= \text{Sum of ACTR} = \sum_i^n ACTR$$

6. % contribution to total Standard Deviation

$$= \frac{ACTR_i}{\text{Portfolio Std.Dev}}$$

7. Ratio of excess return to MCTR

$$= \frac{(\text{Expected Return} - R_f)}{MCTR}$$

8. Surplus Optimization

$$= U_m^{ALM} = E(R_{S,m}) - 0.005\lambda\sigma^2(R_{S,m})$$

Learning Module 5
Asset Allocation with Real-World Constraints

1. After-tax Portfolio Return

$$= r_{at} = r_{pt}(1-t)$$

2. Expected Equity Return (dividend income + Price Appreciation)

$$= r_{at} = p_d r_{pt} (1-t_d) + p_a r_{pt} (1-t_{cg})$$

where, p_d & p_a are proportion attributed to dividend income & price appreciation respectively.

3. Expected after tax standardization =

$$\sigma_{AT} = \sigma_{PT}(1-t)$$

VOLUME 2: PORTFOLIO CONSTRUCTION

Learning Module 1
Overview of Equity Portfolio Management

$$\text{Herfindahl-Hirschman Index (HHI)} = \sum_{i=1}^n w_i^2$$

$$\text{Effective Number of Stocks} = \frac{1}{\sum_{i=1}^n w_i^2} = \frac{1}{\text{HHI}}$$

Learning Module 2
Overview of Fixed-Income Portfolio Management

1. Average Modified Duration

$$\text{AvgModDur} = \sum_{j=1}^J \text{ModDur}_j \left(\frac{MV_j}{MV} \right)$$

where,

MV = market value of portfolio

MV_j = market value of specific bond

2. Average Modified Convexity:

$$\text{AvgConvexity} = \sum_{j=1}^J \text{Convexity}_j \left(\frac{MV_j}{MV} \right)$$

3. Effective Duration:

$$= \frac{(PV -) - (PV +)}{2 \times \Delta \text{Curve} \times (PV_0)}$$

4. Effective Convexity:

$$\text{Effective Convexity} = \frac{(PV -) + (PV +) - 2(PV_0)}{(\Delta \text{Curve})^2 \times (PV_0)}$$

5. Expected Returns:

E(R) ≈ Coupon rate

+/- Rolldown Return

+/- Exp. ΔP due to investor view of benchmark yield

+/- Exp. ΔP due to investor view on yield spreads

+/- Exp. ΔP due to investor view of currency value changes

6. Yield income (or Current yield)

$$= \frac{\text{Annual coupon payment}}{\text{current bond price}}$$

7. Views of Yield Spreads

E(Δ in price based on investor view of yields & yield volatility)

$$= [-MD \times \Delta \text{Yield}] + \frac{1}{2} \times \text{Convexity} \times (\Delta \text{Yield})^2$$

where, E = expected, MD = bond's modified duration, ΔYield = expected change in yield.

8. Roll Down return

$$= \frac{(\text{Bond Price}_{\text{End.}} - \text{Bond Price}_{\text{Beg.}})}{\text{Bond Price}_{\text{Beg.}}}$$

9. Views of Currency Value Changes:

$$R_{DC} = \sum_{i=1}^n w_i (1 + R_{FC,i})(1 + R_{FX,i}) - 1$$