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:

$$V_t^e = GDP_t \times S_t^k \times PE_t$$

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:

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

Where,

i^* = target nominal policy rate
$r_{neutral}$ = real policy rate that would be targeted if GDP growth were on trend & inflation on target
π_e, π_{target} = respectively the expected and target inflation rates
$\hat{Y}_e$, $\hat{Y}_{trend}$ = respectively the expected and trend real GDP growth rates

By readjusting the above equation:

3. Real inflation adjusted target rate

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

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(Re):

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

Where,

- E (Re) = Expected rate of return on equity
- D/P = Expected dividend yield
- %ΔS = Expected % change in number of shares outstanding

2. Under Basic CAPM model

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

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

Where,

$RP_i = [ER_i - R_F]$ risk premium on *i*th asset
$RP_M = [ER_M - R_F]$ risk premium on market portfolio
$\beta_{i,M}$ = ith asset sensitivity to market portfolio = $\frac{Cov(R_i,R_M)}{\sigma_M^2} = \rho_{i,M}\left(\frac{\sigma_i}{\sigma_M}\right)$
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. $\mathrm{RP_i^S} = 1 \times \mathrm{RP_{GM}} = 1 \times \sigma_i \left(\frac{\mathrm{RP_i^S}}{\sigma_i}\right)$

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

7. 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:

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

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

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

9. Implication of capital mobility:
$\mathrm{E}(\%\Delta S_{d/f}) = (\mathrm{r^d} - \mathrm{r^f}) + (\mathrm{Term^d} - \mathrm{Term^f}) + (\mathrm{Credit^d} - \mathrm{Credit^f}) + (\mathrm{Equity^d} - \mathrm{Equity^f}) + (\mathrm{Liquid^d} - \mathrm{Liquid^f})$

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

r_i = *return on ith asset*
α_i = constant intercept
β_{ik} = asset's sensitivity to kth factor
F_k = kth common factor return
ε_i = error term

11. *Variance on ith 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. $var(r) = \left(\frac{1+\lambda}{1-\lambda}\right) var(R) > var(R)$

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

$w_i \times Cov\,(r_i, r_P) = \frac{1}{n}\sigma_P^2$

3. Marginal contribution to risk ($MCTR_i$)
= (Beta of Asset Class *i* relative to Portfolio) x (Portfolio Std. Dev.)

4. Absolute contribution to risk ($ACTR_i$)
= $Asset\ class\ weight_i$ x $MCTR_i$

5. Portfolio Std. Dev. (expected)
= Sum of ACTR = $\sum_i^n ACTR$

6. % contribution to total Standard Deviation
$= \frac{ACTR_i}{Portfolio\ Std.Dev}$

7. Ratio of excess return to MCTR
$= \frac{(Expected\ Return - R_f)}{MCTR}$

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

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

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

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

3. Expected after tax standardization $= \sigma_{AT}$
$= \sigma_{PT}(1\text{-}t)$

VOLUME 2: PORTFOLIO CONSTRUCTION

Learning Module 1
Overview of Equity Portfolio Management

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

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

where,
MV = market value of portfolio
MV_j = market value of specific bond

2. Average Modified Convexity:

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

3. Effective Duration:

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

4. Effective Convexity:

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

5. Expected Returns:

E(R) ≈ Coupon rate
+/— Rolldown Return
+/— $Exp.\Delta P$ *due to investor view of benchmark yield*
+/—$Exp.\Delta P$ *due to investor view on yield spreads*
+/- $Exp.\Delta P$ *due to investor view of currency value changes*

6. Yield income (or Current yield)
$= \frac{Annual\ coupon\ payment}{current\ bond\ price}$

7. Views of Yield Spreads

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

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

where, E = expected, MD = bond's modified duration, $\Delta Yield$ = expected change in yield.

8. Roll Down return
$= \frac{(Bond\ Price_{End.} - Bond\ Price_{Beg.})}{Bond\ Price_{Beg.}}$

9. Views of Currency Value Changes:

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

Where,
R_{DC} & R_{FC} are domestic and foreign currency returns as a %.

R_{FX} = % change of the domestic currency versus foreign currency.

10. Leverage Portfolio Return:

$r_p = \frac{Portfolio\ Return}{Portfolio\ equity}$

$$= \frac{[rI \times (V_E + V_B) - (V_B \times rB)]}{V_E}$$

$$= r_I + \frac{V_B}{V_E}(r_I - r_B)$$

11. Leverage Futures Contracts:

$Leverage_{Futures} = \frac{Notional\ Value - Margin}{Margin}$

12. Repurchase Agreements:

Dollar Interset = Principal × Repo Rate × (Days/360)

13. Rebate rate

Collateral earning rate – Security lending rate

14. Immunized Portfolio Convexity

$$= \frac{\text{MacDur}^2 + \text{MacDur} + \text{Dispersion}}{(1 + \text{Cash flow yield})^2}$$

Learning Module 3
Asset Allocation to Alternative Investments

1. Capital Contribution in Year t:

$C_t = RC_t \times (CC - PIC_t)$

where
PIC = Paid-in Capital

2. Distributions

$D_t = RD_t[NAV_{t-1} \times (1 + G)]$

$NAV_t = [NAV_{t-1} \times (1 + G)] + C_t - D_t$

3. Distributions at Time t

= Rate of distribution at time t × [NAV × (1 + Growth Rate)]

4. NAV at time 1

= prior NAV × (1 + Growth Rate) + Capital Contribution – Distributions

Learning Module 4
An Overview of Private Wealth Management

1. Human Capital

$HC_0 = \sum_{t=1}^{N} \frac{W_t}{(1+r)^t}$ extended model $HC_0 = \sum_{t=1}^{N} \frac{p(S_t)\, W_{t-1}(1+g_t)}{(1+r_f+y)^t}$

2. Mortality Weighted NPV

$= mNPV_0 = = \sum_{t=1}^{N} \frac{p(s_t)\, b_t}{(1+r)^t}$

3. Future Value Interest Factor

$FVIF_T = [1 + R(1 - t_X)]^T$

4. After Tax Future Accumulation

$FVIF_{CG}$
$= (1+R)^T - [(1+R) - 1]^T \times t_{CG}$
$= (1+R)^T(1 - t_{CG}) + t_{CG}$

5. The Impact of Different Tax Rates, Sources of Return, and Inflation

$FVIF_{CG}$
$[1 + R_{INC}(1 - t_X)]^T$
$+ (1 + R_{CAPITAL})^T(1 - t_{CG}) + t_{CG}$

6. Income yield (payout)

$= \frac{total\ ongoing\ annual\ income}{initial\ purchase\ price}$

Learning Module 5
Portfolio Management for Institutional Investors

1. Relationship between Assets and Liabilities

Assets (A) = liabilities (L) + equities (E)

$\Delta A = \Delta L + \Delta E$

- $\frac{\Delta A}{A}\left(\frac{A}{E}\right) = \frac{\Delta L}{L}\left(\frac{L}{E}\right) + \frac{\Delta E}{E}$
- $\frac{\Delta E}{E} = \frac{\Delta A}{A}\left(\frac{A}{E}\right) - \frac{\Delta L}{L}\left(\frac{A-E}{E}\right)$
- $\frac{\Delta E}{E} = \frac{\Delta A}{A}\left(\frac{A}{E}\right) - \frac{\Delta L}{L}\left(\frac{A}{E} - 1\right)$