FinQuiz Formula Sheet CFA Program Level III

Reading 1: The Behavioral Biases of Individuals

Reading 2: Behavioral Finance & Investment Processes

1. After-tax (AT)*Real* required return (RR) % $= \frac{\text{Client's required expenditures in Year n}}{\text{Net Investable Assets}} = \frac{\text{Projected needs in Year n}}{\text{Net Investable Assets}}$

2. AT*Nominal* RR % $= \frac{\text{Projected needs in Year n}}{\text{Net Investable Assets}}$ + Current Annual (Ann) Inflation (Inf) % = AT real RR% + Current Ann Inf% *Or* AT*Nominal* RR% = (1 + AT Real RR%) × (1 + Current Ann Inf %) – 1

3. Total Investable assets = Current Portfolio -Current year cash outflows + Current year cash inflows

4. Pre-tax income needed = AT income needed / (1-tax rate)

5. Pre-tax Nominal RR = (Pre-tax income needed / Total investable assets) + Inf%

<u>If Portfolio returns are tax-deferred:</u>

6. Pre-tax projected expenditure $ = AT projected expenditure $ / (1 – tax rate)

7. Pre-tax real RR % = Pre-tax projected expenditures $ / Total investable assets

8. Pre-tax nominal RR = (1 + Pre-tax real RR %) × (1 + Inflation rate%) – 1

<u>If Portfolio returns are NOT tax-deferred:</u>

9. AT real RR% = AT projected expenditures $ / Total Investable assets

10. AT nominal RR% = (1 + AT real RR%) × (1 + Inf%) – 1

11. Procedure of converting nominal, pre-tax figures into real, after-tax return:
    - Real AT R = [Expected total R – (Expected total R of Tax-exempt Invst × wt of Tax-exempt Invst)] × (1 – tax rate) + (Expected total R of Tax-exempt Invst × wt of Tax-exempt Invst) – Inf rate

Or

    - Real AT R =[(Taxable R of asset class 1 × wt of asset class 1) + (Taxable R of asset class 2 × wt of asset class 2) + …+ (Taxable return of asset class n × wt of asset class n)] × (1 – tax rate) + (Expected total R of Tax-exempt Invst × wt of Tax-exempt Invst) – Infrate

Reading 3: Capital market Expectations: Part 1

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

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:

Real inflation adjusted target rate =

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

2. **Net exports** = Net Private Savings + Government Surplus
   (X–M) = (S–I) + (T-G)

3. Government Surplus = Taxes – Government spending

Reading 4: Capital market Expectations: Part 2

1. $E(R_e) \approx \frac{D}{P} + (\%\Delta E - \%\Delta S) + \Delta P/E$
   Where,
   - $E(R_e)$ = Expected rate of return on equity
   - D/P = Expected dividend yield
   - %ΔS = Expected % change in number of shares outstanding

2. Under Basic CAPM model:
   - $RP_i = \beta_{i,M} RP_M$
   - $\beta_{i,M} = Cov(R_i, R_M)/\sigma_M^2 = \rho_{i,M_i} \left(\frac{\sigma_i}{\sigma_M}\right)$

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

Expected Return using Singer-Terhaar Model
Model's 1st component (full integration assumption):

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

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

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

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

6. Cap rate = $\frac{\text{Current year's NOI}}{\text{Property value}}$, where NOI = net operating Income

7. $E(R_{re})$ = 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

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

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

10. $Variance\ on\ ith\ asset = \sigma_i^2 = \sum_{m=1}^{K} \sum_{n=1}^{K} \beta_{im}\ \beta_{jn}\ \rho_{mn} + v_i^2$

where,
ρ_{mn} = covariance between the *m*th and *n*th factor
v_i^2 = variance of *i*th asset return

11. Covariance between *i*th and *j*th = $\sigma_{ij} = \sum_{m=1}^{K} \sum_{n=1}^{K} \beta_{im}\ \beta_{jn}\ \rho_{mn}$

12. $Current\ return = R_t = (1 - \lambda) r_t + \lambda\, R_{t-1}$
where $\lambda\ may\ range\ from\ 0\ to\ 1$

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

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

Rearranging the above equation:
$\sigma_t^2 = \gamma + (\alpha + \beta)\sigma_{t-1}^2 + \beta(\eta_t^2 - \sigma_{t-1}^2)$

Reading 5: Overview of Asset Allocation

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

Reading 6: Principles of Asset Allocation

1. $U_m = E(R_m) - 0.005\lambda\sigma_m^2$
2. $w_i \times Cov\,(r_i, r_P) = \frac{1}{n}\sigma_P^2$
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 Std Dev = $\frac{ACTR_i}{Portfolio\ Std.Dev}$
7. Ratio of excess return to MCTR = $\frac{(Expected\ Return - R_f)}{MCTR}$
8. Surplus Optimization = $U_m^{ALM} = E(R_{S,m}) - 0.005\lambda\sigma^2(R_{s,m})$

Reading 7: 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. $Expected\ after\ tax\ standardization = \sigma_{AT} = \sigma_{PT}(1\text{-}t)$

Reading 8: Option Strategies

1. Put-call parity: $S_0 + p_0 = c_0 + X/(1 + r)^T$ where:
   - S_0 = price of underlying
   - p_0 = price (i.e. premium) of put option
   - c_0 = price (i.e. premium) of call option
   - $X/(1 + r)^T$ = present value of the risk-free bond
2. Put-call-forward parity: $F_0(T)/(1 + r)^T + p_0 = c_0 + X/(1 + r)^T$
3. Converting monthly volatility to annual volatility: $\sigma_{Monthly}(\%) = \sigma_{Annual}(\%)/\sqrt{\frac{252}{21}}$

Reading 9: Swaps, Forwards, & Futures

1. Swap Notional Principal: $N_S = \left(\frac{MDUR_T - MDUR_P}{MDUR_S}\right)(MV_P)$
2. Principal invoice amount = (Future settlement price/100) × CF × Contract size

Hedge ratios:

3. HR without considering CTD bond = $\frac{\Delta P}{\Delta F}$
4. HR when considering CTD bond = $\frac{\Delta P}{\Delta CTD}(CF)$
5. portfolio's target BPV= $BPV_T = MDUR_T \times 0.01\% \times MV_P$
6. BPV of Portfolio to be hedged or $BPV_P = MDUR_P \times 0.01\% \times MV_P$
7. BPV of futures contract = $BPV_F = BPV_{CTD}/CF$
8. BPV of CTD = $BPV_{CTD} = MDUR_{CTD} \times 0.01\% \times MV_{CTD}$

Where, MV_{CTD} = (CTD price/100) × Future contract size