Risk management and Investment management

99% → 2.33 (one-tail)
95% → 1.96 (two-tail)

R1: Factor investing.

1. Factor theory: (3个观点)
   ① factor matters, not asset.
   ② assets are bundles of factors
   ③ different investors needs different risk factor.

2. Factor theory $\xrightarrow{\text{Explain}}$ Phenomenon:

3. CAPM: $E(R_p) = R_f + \beta[E(R_m) - R_f]$: passitive investment
   - $E(R_p) - R_f$: risk premium.
   - $E(R_m) - R_f$: market risk单价/price
   - β: 承担的量.

4. APT arbitrage pricing Theory: multi-factor model

5. Inefficient market:
   i) Rational explanation: define bad times: ⟶ volatility
   ii) Behaviour explanation: under/overreaction to news or events
   ↓
   momentum
   risk premium
   (追涨杀跌)
   inefficient update of beliefs;
   ignore some information;

6. Types of factors:
   ① macro, fundamental-based factors:
   → economic growth: government bond. 特例
   → inflation: commodity 特例
   → volatility: 可投资的 factor
   productivity, demographic risk.

   ② Investment-style factors:
   → static factors: buy and hold. (market factor)
   → dynamic factors: constant trading (short & long)
   ↓
   Fama-French: market factor, size effect, value/growth effect
   SMB factor HML factor $\frac{\text{Book value}}{\text{Market value}}$ < market

7. Volatility: ex-post: realized return

① leverage effect: $\rho(R,\sigma)<0$

→ explain: 1) financial leverage: $\uparrow L=\frac{A}{E\downarrow}$ P↓ ,σ↑

2) Required return.: risk↑ → σ↑ → E(Ri)↑ → $P=\sum\frac{CF}{(1+E(r_i))^t}$

② Volatility Protection:

- volatility swap: 收float 支 fixed σ
- Buy put (out-of the money) σ↑, P↓ put payoff, 虚值put, cost 少.
- Buy Bond.

③ Risk to sell volatility protection.

- $\rho(\sigma,R)$ time varying

8. Fama-French: market factor, size effect ✓, value/growth effect

SMB factor HML factor

- HML factor: long value stock, short growth stock 价值股-成长股

→ 帐面市值比: $\frac{\text{Book value}}{\text{Market value}}$ 1) market value↓ → 价值股 (Book value高) → high and asymmetric adjustment cost.

2) market value↑ → growth stock.

→ value stock can underperform growth stocks during certain period.

- Size effect (SMB factor): Rs-Rb 小盘股-大盘股

- Cahart Four Factor model:

→ $E(R_p)=R_f+\beta_{mrk}[E(R_m)-R_f]+\beta_{SMB}\cdot E(SMB)+\beta_{HML}\cdot E(HML)+\beta_{WML}\cdot E(WML)$

9. Momentum WML, UMD (买涨卖跌): Matthew Effect.

↓ winner-loser.

- short run: rebound / long run: eventually reverse
- Momentum > size, value strategy

10. Value and Momentum Investment Strategies:

① Same: cross-sectional

② Difference: Value: negative feedback strategy: P↑ ⇒ Short

Momentum: Positive feedback strategy: P↑ ⇒ long

11. Factor Regression

① risk-adjusted factor benchmark

② mimic portfolio; changes in style weights reflect changes in investment styles.

12. low-risk Anomaly: β↓, σ↓ and Return↑

① effect:

- $\rho(\sigma, R) < 0$
- $\rho(\beta, R) < 0$
- minimum variance portfolio do better.

② Data evidence:

- $\rho(\sigma_t, R_{t+1}) < 0$
- $\rho(\sigma_t, R_t) < 0$
- $\rho(\beta_t, R_{t+1}) < 0$ (but insignificant)
- $\rho(\beta_t, R_t) > 0$

③ Explanation:

- Data Mining
- Leverage constraints (融资限制)
- agency problem.
- preferences

R2: Portfolio construction.

1. Input:

- current Portfolio
- α
- ρ covariance
- TC. Transaction cost.
- active risk aversion:

2. Refine α: in line with manager's desires

① Scale: $\alpha = \sigma \times IC \times Score$. → Score ~ $N(0,1)$

↓ $N(0, \sigma^2 IC^2)$; IC: Information coefficient ρ(forecast, actual)

② Trim α outliers: $\pm 3\sigma$

③ $\alpha_{Benchmark} = 0$: Neutralization: $\alpha'_p = \alpha_p - \beta \cdot \alpha_B$

3. Transaction cost:

- rebalance. { frequent revision / less frequent revision.
- Optimal No-Trade Region with transaction cost
  → decide 是否调仓.
  →
  - Sales Cost ≤ MCVAn ≤ Purchase Cost PCn.
    (MCVAn: value added)
  - value added : $\alpha_n - 2\cdot\lambda_A\cdot\varphi\cdot MCAR_n$.
  ⇒ $2\cdot\lambda_A\cdot\varphi\cdot MCAR_n - SC_n \le \alpha_n \le PC_n + 2\cdot\lambda_A\cdot\varphi\cdot MCAR_n$
  (λ_A: 风险厌恶程度; SC_n: 卖出成本; PC_n: 买入成本; $MCAR_n$: 没产引入对风险改变量.)
- Dispersion: $R_{max} - R_{min}$, { client / manager
  trade-off : dispersion, rebalance cost.

4. Active risk aversion: $U = E(r) - \frac{1}{2}\cdot A\cdot\sigma^2$

- $\lambda_A = \frac{IR}{2\times\varphi}$ $\quad U = \alpha - \lambda\cdot\varphi^2$ ($\lambda>0$ → risk averse)
  $= IR\cdot\varphi - \lambda\cdot\varphi^2$ $\quad (-\frac{b}{2a})$
- classify : { specify risk aversion / common-factor risk aversion.

5. Portfolio construct techniques:

① screens : rank by alpha ⟶ equal/ capitalization-weight.
→ easy, diversification.
→ ignore other information, exclude categories (tend to have low alpha)
行业过度集中 → low risk control

② Stratification : divide by categories
→ 避免行业过度集中. ignore biases in alpha across categories

③ Linear programming : { α-TC ⇒ max / risk : build portfolio close to benchmark portfolio.
→ characterizes stocks along dimensions of risk.
→ take all information
→ difficulty producing portfolio with a pre-specified number of stocks :
risk control characteristics conflict with the alpha.

④ Quadratic Programming: ultimate.

- consider: alpha, risk, transaction cost.
- more inputs means more noise

R3 : Portfolio Risk Measures

1. individual VaR : $VaR_i = |E(R_i) - z \cdot \sigma_i| \times V_i$

$E(R_i) = 0$

$= z_c \cdot \sigma_i \cdot |V_i| = z_c \cdot \sigma_i \cdot |w_i| V_p$

2. $\rho \neq 1$: $VaR_p^2 = VaR_1^2 + VaR_2^2 + 2\rho \cdot VaR_1 \cdot VaR_2$

$\rho = 1$: undiversified VaR: $VaR_p = VaR_1 + VaR_2$

3. 3个延伸的VaR值:

① Marginal VaR : +1$ asset → $\Delta VaR_p = MVaR_i$

$$MVaR_A = \frac{\partial VaR_p}{\partial V_A} = \frac{\partial z \sigma_p \cdot V_R}{\partial w_A \cdot V_R} = z \cdot \frac{\partial \sigma_p}{\partial w_A}$$

$$\Rightarrow MVaR_A = z_\alpha \times \frac{Cov(R_A, R_p)}{\sigma_p}$$

$$= z_\alpha \times \rho_{A,p} \times \sigma_A$$

$$= z_\alpha \times \beta_{A,p} \times \sigma_p$$

$$= \frac{VaR_p}{V_p} \times \beta_{A,p}$$

② Incremental VaR: Δ VaR owing to a new position

- Incremental VaR = $VaR_{a+p} - VaR_p$
- full revaluation:
- Approximate: Incremental VaR ≈ $MVaR_A \times V_A$.

③ Component VaR: 单个头寸对整体组合的贡献度.

- component VaR sum to portfolio VaR

$$CVaR_A = MVaR_A \times V_A = \frac{VaR_p}{\sigma_p} \times \beta_{p,A} \times V_A / VaR_p$$

$$\Rightarrow CVaR_A = VaR_p \times w_A \times \beta_{A,p}$$

$$\Sigma w_i \beta_{i,p} = 1$$

$$\Rightarrow \frac{CVaR_A}{VaR_p} = w_A \times \beta_{A,p}.$$

R4: Portfolio Risk Management

1. VaR application to different risks:

① Absolute Risk vs. Relative Risk: 50比 / benchmark比

risk of -1$.

Tracking error (TE) = $R_P - R_B$

Tracking error volatility $TEV = \sigma(R_P - R_B) = \sqrt{\sigma_P^2 + \sigma_B^2 - 2\rho\sigma_P\sigma_B}$

$\begin{cases} VaR_P = Z \cdot \sigma_P \cdot V_P \\ VaR_P = Z \cdot TEV_P \cdot V_P \end{cases}$

② Policy mix risk vs. Active management risk

passitive 投资

- Total VaR ≤ policy mix VaR + Active management VaR
  - ↑ major.
  - diversification.

③ Funding risk:

- Surplus: $S = Asset - Liabilities$.

$\Delta S = A_0 \cdot r_A - L_0 \cdot r_L$

Expected Surplus $E(S_1) = A_0(1 + r_A) - L_0(1 + r_L)$

→ surplus at risk = $Z \cdot \sigma_{surplus}$. (one-tail)

→ $\sigma_S = \sigma(A-L) = \sqrt{(A \cdot \sigma_A)^2 + (L \cdot \sigma_L)^2 - 2\rho_{A,L} \cdot (A \cdot \sigma_A)(L \cdot \sigma_L)}$

V_A ↓ ¥ $ V_L ↓ ¥ $

→

S_1

$S_1 = E(S_1)$ - surplus at risk = $E(S_1) - Z \cdot \sigma_{surplus}$.

surplus (one tail)

④ Sponsor risk: { Cash-flow risk.: 贡献的资金不确定
Economic risk: 赚取收益的不确定

2. Risk budgting:

① budgting across asset classes:

→ top down

→ asset class → managers → security.
(total VaR)

→ First, determine total VaR at Risk (VaR)
Second, optimal allocation of asset

② Budgting across active manager:

$$w_i = \frac{IR_i / TEV_i}{IR_P / TEV_P}$$

- $IR_i = \frac{R_P - R_B}{\sigma(P-B)} = \frac{TE}{TEV}$ $\begin{cases} TE = R_P - R_B \\ TEV = \sigma(e) = \sqrt{\sigma_P^2 + \sigma_B^2 - 2\cdot\rho\cdot\sigma_P\sigma_B} = \sigma(P-B) \end{cases}$

. $\Sigma w_i > 1$ short benchmark. 多余 fund ⇒ manager.

$\Sigma w_i = 1$ 100%

$\Sigma w_i < 1$ 剩余 fund ⇒ benchmark

③ Budgting across Portfolio

→ minimum portfolio risk:

- global minimum. • $MVaR_A = MVaR_B$

$$\frac{VaR_P}{V_P} \cdot \beta_{A,P} = \frac{VaR_P}{V_P} \times \beta_{B,P} \Rightarrow \beta_{A,P} = \beta_{B,P} = 1$$

$$\Rightarrow VaR_P = CVaR_A + CVaR_B$$
$$= MVaR_A \times V_A + MVaR_B \times V_B$$
$$= \frac{VaR_P}{V_P} \times \beta_{A,P} \times V_A + \frac{VaR_P}{V_P} \times \beta_{B,P} \times V_B$$

$$1 = W_A \times \beta_{A,B} + W_B \times \beta_{B,P}$$

$$\Rightarrow \beta_{A,P} = \beta_{B,P} = 1$$

- highest sharp Ratio: $\max \frac{R_P - R_f}{\sigma_P}$, $\frac{R_P - R_f}{VaR_P}$ max
  - Best combination of expected risk and return.
  - $\frac{R_i - R_f}{MVaR_i} = \frac{R_j - R_f}{MVaR_j}$
  - $\frac{R_i - R_f}{\beta_{i,P}} = \frac{R_j - R_f}{\beta_{j,P}}$

3. Liquidity consideration

① Liquidity duration: (清仓某个头寸所要花费时间)

$$LD_i = \frac{Q_i}{0.15 \times V_i}$$ Q_i → shares / total. V_i → trading volume of security

→ liquidate a portfolio, without material market impact.

R5: Performance measurement and evaluation (5种)

① Green zone: (green zone, yellow zone, red zone) 粗糙

② Sharpe and IR.:

→ SR: $\frac{R_p - R_f}{\sigma_p}$

M^2: 调 risk; $M^2 = \frac{\sigma_M}{\sigma_p}(R_p - R_f) - (R_M - R_f) = \sigma_M(SR_p - SR_M)$ Modigliani-squared.

→ IR = $\frac{\alpha}{\sigma_\alpha} = \frac{R_p - R_B}{\sigma_{(p-B)}}$ → TE/TEV

→ Jensen's alpha: $\alpha_p = E(R_p) - [R_f + [E(R_m) - r_f]\beta]$

→ Treynor ratio: $TR = \frac{R_p - R_f}{\beta_p}$

• Holding Period Return $r_i = \frac{P_{t+1} - P_t}{P_t}$

Time-weight return => $(1 + r_B)^n = (1+r_1)(1+r_2)\cdots$

Dollar-weight return: PV(outflow) = PV(inflow)

2. Fundamental Law of Active management:

$IR \approx IC \times \sqrt{BR}$

information coefficient ρ(forecast, real)

breadth (基金经理勤奋程度)

• limitation: ignore.... real-world consideration.

assume forecasts are idependent of each other.

3. Performance EValuation

1) alpha: benchmark: $R_p - R_f = \alpha + \beta(R_m - r_f) + \epsilon$

peer group: $R_p - R_f = \alpha + \beta(R_{peer} - r_f) + \epsilon$

2) $H_0: \alpha = 0$, $H_A: \alpha \neq 0$, t-test, two-tails.

$t = \frac{\alpha - 0}{\sigma_\alpha/\sqrt{N}} = \frac{\alpha}{\sigma_\alpha}\sqrt{N} = IR \cdot \sqrt{N}$.

4. Attribution of returns: identify the sources of value addition to the portfolio

→ attribute to "risk asset classes/sector, security within an asset class"

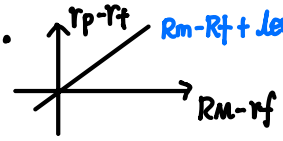
• contribution from asset allocation: $[W_{Pi} - W_{Bi}]R_{Bi}$

• contribution from security selection. $W_{Pi}[R_{Pi} - R_{Bi}]$

• total: $W_{Pi} \times R_{Pi} - W_{Bi} \times R_{Bi}$

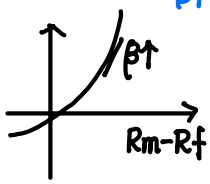
5. Market timing ability:

- Shift funds between the market index portfolio and risk-free assets:



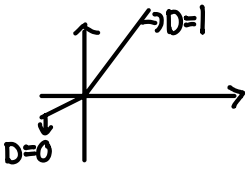
Rm-Rf + leverage, slope>0

No-timing market



β↑ with expected market excess return.

- market timing (Treynor and Mazuy)
- $r_p - r_f = a + b(r_m - r_f) + c(r_m - r_f)^2 + e_p$



Market Timing (Henriksson and Merton)

$r_p - r_f = a + b(r_m - r_f) + c(r_m - r_f)D + e_p$

D: dummy variable.

(2) Call option model: portfolio: { call: $x = S_0(1+r_f)$; bond: $FV = S_0(1+r_f)$

- max (Rm, Rf)
- pay: premium >/ fee for timing ability.

R6: Hedge Fund

- not open to general
- less regulation
- can short, leverage, derivatives

1. Bias:

① survivorship bias;

② Self-selection bias → put the best face forward.

③ Backfill bias: a new fund enters the database.

2. Strategies

① Directional strategies:

→ managed futures (trend follow): invest in listed bond, commodity futures

→ global macro: top down, political trends, global macroeconomic events

② Event-driven strategy:

→ risk arbitrage / merger arbitrage. long target, short acquiring

- deal risk

→ distressed securities: 低 high-yield bond: Price low, → long → restructing → Price↑ → gain

③ Relative value and arbitrage-like strategies

→ fixed-income arbitrage: bond, swap, yield-curve (long, short position in similar fixed-income

→ convertibe arbitrage:

- convertible bond = pure bond + call on stocks { $S_T > X$, stock ; $S_T < X$, bond.

↑ illiquid asset. ← undervalued

• long convertible bond = long pure bond + long call op

B C Δ τ Λ

short treasury B　　short stock (Δ份)

$\text{Delta} = \frac{\Delta \text{Option}}{\Delta \text{stock}} \Rightarrow \Delta \text{option} = \text{Delta} \cdot \Delta \text{stock}$

• Net long gamma and vega (non-directional)

→ • Long / Short Equity. : both long and short sides of equity market

④ Niche Strategies:

→ dedicated short bias (net short position)

→ emerging market: developing countries markets

→ equity market neutral: $\beta = 0$

profit: idiosycratic

non-directional

3. FOF Funds of Hedge funds:

- portfolios of hedge fund.
- optimal diversification
- additional management fees

R7: Due Diligence and Fraud risk

1. due diligence process

① investment process: investment strategy
Record

② Related risk control: valuation method { • mark to model • mark to market

③ Operational environment

④ Model risk and fraud risk

2. detect fraud: ADV

- Significant predictor: • Post regulatory violation: SEC examination
  - conflict of interest.: referral fee, interest in transaction
  - monitoring
    - → broker in firm
    - → investment company act
    - → larger investors
    - → percent client agents.
- barriers and cost
- improve investor's ability