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Investment Risk Management

FRM二级培训项目



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Investment Risk Management

- 1 Portfolio Construction
- 2 Portfolio Risk
- 3 Risk Monitoring And Performance Measurement
- 4 Portfolio Performance Evaluation



Practical Topic

- 5 Portfolio Choice With Illiquid Assets
- 6 Hedge Funds
- 7 Performing Due Diligence On Specific Managers And Funds



Section 1



PORTFOLIO CONSTRUCTION

Portfolio Construction Process

选定风险资产→Asset Allocation (马克维茨有效前沿)

↓ 如何选择风险资产

Portfolio Construction

- Current Portfolio→**Certain**
- Alphas
- Covariance Estimates
- Transaction Costs
- Active Risk Aversion

5个Input

Input 1: Refining Alphas

Motivation For Refining Alphas

investor
manager

Constraints→**Refining Alphas**解决构建组合的复杂性为题

↓ **refine the alphas**方法

Method 1: Scaling Technique

$\text{Alpha}(a) = \text{Volatility} \times \text{IC} \times \text{Score}$

Method 2: Trimming Technique

- Delete alphas due to **questionable data**

Method 3: Neutralization

- **Benchmark Neutralization**
- **Cash-Neutral Alphas**→消除cash alpha
- **Risk-Factor-Neutral Alphas**→消除基金经理运气导致的alpha

Input 2: Active Risk Aversion

Risk Aversion

$$\text{Risk Aversion} = \frac{IR}{2 \times \varphi_p}$$

确定risk aversion
很重要 → Reason

- 帮基金经理意识到 **huge losses**
- **appropriate aversion risk factors**

Input 3: Transaction Costs

Alpha { Active risk → one dimension
Cost → Two dimension



Transaction cost → 影响 rebalancing

-(cost of selling) < MCVA < (cost of purchase)

MCVA = (alpha of asset) - [2 × (risk aversion) × (active risk) × (marginal contribution to active risk of asset)]

[2 × (risk aversion) × (active risk) × MCAR] -
(cost of selling)

[2 × (risk aversion) × (active risk) × MCAR] +
(cost of purchase)

alpha of asset

No-trade range for alpha

Other Issue

Proper alpha coverage addressing the case

- The manager has forecasts of stocks that are not in the benchmark → **benchmark weight of zero**
- The manager doesn't have forecasts for assets in the benchmark → Alphas can be **inferred**



筛选股票方法

Method 1: Screens

- Rank the stocks by alpha
- Choose the top performers
- Form either an equally-weighted portfolio or a capitalization-weighted portfolio of stocks



Strengths	Shortcomings
Easy to understand, clear link between cause and effect	Ignore all information
Easy to computerize	biases in the alphas
Robust, wild estimates alphas do not alter the result	Ignore certain industry with low alpha
concentrating in the high-alpha stocks.	fails in addressing risk control purposes
limiting the transactions costs by controlling turnover	

Method 2: Stratification

- splitting the list of followed stocks into mutually exclusive categories
- Stratification ensures that the portfolio matches the benchmark

Strengths	Shortcomings
<ul style="list-style-type: none">• Same benefits as screening• solved the problem of the possible exclusion of some categories of assets	Still suffers from possible errors in measuring alphas.

Method 3: Linear Programming

- Uses a type of stratification based on characteristics such as industry, size, volatility, beta, etc. without making the categories mutually exclusive.
- can also include transactions costs

Strengths	Shortcomings
<ul style="list-style-type: none">• Create a portfolio that closely resembles the benchmark.	can be different from the benchmark with respect to the number of assets and risk characteristics.

Method 4: Quadratic Programming

- Explicitly considers alpha, risk, and transactions costs.
- ultimate approach

Dispersion

Dispersion

- The difference between the maximum return and minimum return for separate account portfolios.
- It is a measure of how an individual client's portfolio may differ from the manager's reported composite returns.



来源

Sources of Dispersion

- **Client-driven**: clients impose different constraints.
- **Lack of attention** to separate accounts

Controlling Forms of Dispersion

- If **transactions costs** were **zero**, **Dispersion would disappear**, at no cost to investors.
- With transactions costs, managers should consider transactions costs.



Section 2



PORTFOLIO RISK: ANALYTICAL METHODS

Portfolio Risk: Analytical Methods

Portfolio VAR Measures

Portfolio VAR

$$\text{VAR}_p = a \times \sigma_p \times W$$

$$\rightarrow \begin{cases} \text{Diversified VAR} = \sqrt{\text{VAR}_1^2 + \text{VAR}_2^2} \\ \text{Undiversified VAR} = \text{VAR}_1 + \text{VAR}_2 \end{cases}$$

Individual VAR

$$\text{VAR}_i = \alpha \times \sigma_i \times |W_i| = \alpha \times \sigma_i \times |w_i| \times W$$

Effect Of Correlation

$$\text{VAR}_p = a_c \times W \times \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2w_1 w_2 \rho_{12} \sigma_1 \sigma_2}$$

Other Portfolio VAR Measures ★ ★

Marginal VAR $\rightarrow \Delta=1$

$$\begin{aligned} \text{MVAR} &= z_c \times \frac{\partial \sigma_p}{\partial w_i} = z_c \times \frac{\text{Cov}(R_i, R_p)}{\sigma_p} \\ &= z_c (\beta_i \times \sigma_p) = z_c (\rho_i \times \sigma_i) = \frac{\text{VaR}}{W} \times \beta_i \end{aligned}$$

Incremental VAR $\rightarrow \Delta=\text{any } \$$

$$\begin{aligned} \text{Incremental VAR} \\ &= \text{VAR}_{p+a} - \text{VAR}_p \end{aligned}$$

Component VAR $\rightarrow \Delta=p_i$

$$\begin{aligned} \text{CVAR}_i &= \text{MVAR}_i \times P_i = \beta_i \times w_i \times \text{VAR}_p \\ \text{Percent contribution} &= \frac{\text{CVAR}_i}{\text{VAR}} = \beta_i \times w_i \end{aligned}$$

Managing Portfolios Using VAR

From Risk Measurement to Risk Management

- **Decrease** portfolio risk by reducing positions with the **highest marginal VAR**.
- Repeat process until reached a global minimum.

- **Increase position with highest SR**

$$\frac{\text{Position i return} - \text{risk free rate}}{\text{MVar}_i} = \frac{\text{Position j return} - \text{risk free rate}}{\text{MVar}_j}$$

Types Of Risk

Absolute risk

- Policy-mix risk
- Active-management risk

- **Most** of the risk is due to the **policy mix**
- the **active-management** VAR is rather **small**.
- the policy-mix VAR and active-management VAR **do not add up to the total-asset VAR**.

Relative risk

→ Funding Risk
→ **Sponsor Risk**

- **Cash-flow risk**: Risk of year-to-year fluctuations in **contributions** to the fund.
- **Economic risk**: Risk of variation in total **economic earnings** of the plan **sponsor**.

$$R_{\text{surplus}} = R_{\text{asset}} - R_{\text{Liabilities}} \left(\frac{\text{Liabilities}}{\text{Assets}} \right)$$

VAR And Risk Budgeting

Managing Risk With VAR

Buy side vs. Sell side

Characteristic	Sell side	Buy side
Horizon	Short-term (1 day or less)	Long-term (quarter or longer)
Turnover	Rapid	Slow
Leverage	High	Low
Risk measures	VAR Stress test	Asset allocation Tracking error
Risk controls	Position limits VAR limits Stop-loss rules	Diversification Benchmarking Investment guidelines

- the horizon is **short**, turnover **rapid**, and leverage **high**. **VAR** is particularly **appropriate**.
- historical** measures of risk are **useless**.
- portfolios are **highly leveraged**, **important to control their risk**.

- the horizon is much **longer**. Positions change more **slowly**.
- Thus, there is a **less crucial** need to control the downside risk.

VAR is important

- investments are becoming more **global** in nature, creating a need for risk measures that **take diversification** into account.
- Second, financial instruments are becoming more **complex** over time.
- Third, most investment portfolios are **dynamic**, with **changing** positions

Budgeting Risk

Budgeting Risk ^{原则} → Top-down allocation

Budgeting across Asset Classes

- *maximize return at a targeted level of risk.*
 - First, determine the *total Value at Risk* (VaR).
 - Second, choose the *optimal allocation of assets* given the *total risk profile*.

Budgeting across Active Managers

weight of portfolio managed by manager i

$$= \frac{IR_i \times (\text{Portfolio's tracking error volatility})}{IR_p \times (\text{manager's tracking error volatility})}$$



Section 3



RISK MONITORING AND PERFORMANCE MEASUREMENT

Risk Monitoring

Risk Monitoring四步骤

Risk Measures → *Risk Planning* → *Risk Budgeting* → *Risk Monitoring*

Risk Measures

与前面学过内容相同

Value at Risk (VaR)	Tracking Error (TE)
Value at Risk is the maximum dollar earnings / loss potential over a given time period at a given level of statistical confidence.	Tracking error is simply the standard deviation of excess returns, i.e. the difference between the portfolio's returns and the benchmark's returns.
VaR associated with any given asset class is based on the combination of risks associated with that asset class and risks associated with active management.	Tracking Error is used to describe the extent to which an investment manager is allowed latitude to differ from the index (active management)
VaR is used to measure potential downside risk in standalone terms.	TE is used to assess risk and return relative to a benchmark.
If asset's returns are normally distributed, 67% of all outcomes lie within the asset's average returns +/-1 standard deviation.	If excess returns are normally distributed, 67% of all outcomes lie within the benchmarks returns +/-1 standard deviation.

Risk Planning

Objectives of risk planning 要高管参与

- Setting expected return and risk targets
- Exploring factors that could cause a business plan to fail.
- Helping management understand uncertainty levels.
- Creating a vision that outlines how risk capital is to be deployed
- Helping identify potential severe losses
- Identifying critical dependencies

Risk Budgeting

Risk Budgeting

- Set the minimum acceptable Wels
- Apply mean-variance optimization
- Simulate the portfolio performance

Risk Monitoring

Is used to check for deviations from defined risk targets in order to ensure that **risk capital** is used in a manner **consistent with the risk budget**.

**fundamental
role**

- It helps ensure that the organization is entering into transactions that are **authorized and properly scaled**.
- It helps distinguish between events that are unusual and those that should have been **anticipated**.

Investment management For Organization

Risk Consciousness

- Many organizations and asset managers have formed independent Risk Management Units (RMUs) as a result of the heightened level of risk consciousness.

RMU功能

- Gathering, monitoring, analyzing, and distributing risk data
- Helping develop a disciplined process
- setting and implementing the risk agenda
- Monitoring risk trends
- Acting as a convergence point of the firm
- Promoting enhanced risk awareness
- Developing risk measurement and performance attribution analytical tools
- Measuring portfolio's potential tracking error
- Developing an inventory of quality risk data
- Promoting transparency of risk

Liquidity considerations are important

- Because a portfolio's liquidity profile could change significantly in the midst of a volatile market environment or an economic downturn, for instance.
- Therefore, measuring portfolio liquidity is a priority in stress testing.

Liquidity duration

$$LD = \frac{Q}{0.01 \times V}$$



Section 4



PORTFOLIO PERFORMANCE EVALUATION

Portfolio Performance Evaluation

Return计算

Time-weighted Return $R_g = [(1+r_1)(1+r_2)\dots(1+r_n)]^{1/n} - 1$ → *not affected* by *cash inflows* or *outflows*
 Dollar-weighted Return → 求IRR

Risk-adjusted Performance Measures

Sharpe Ratio

$$SR = \frac{E(R_P) - R_F}{\sigma(R_P)}$$

Total Risk

Treynor Ratio

$$TR = \frac{[E(R_P) - R_F]}{\beta_P}$$

Systematic Risk

Jensen's alpha

$$\alpha_P = E(R_P) - \{R_F + \beta_P [E(R_M) - R_F]\}$$

Systematic Risk

Information Ratio

$$IR = \frac{\alpha}{\sigma(e_P)}$$

Non-Systematic Risk

M^2

$$\frac{\sigma_M}{\sigma_P} (R_P - R_f) - (R_M - R_f)$$

Total Risk

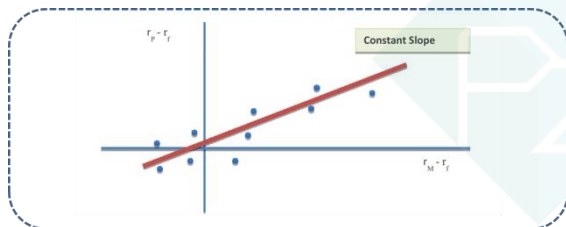
排序结果与SR相同

Other Evaluation Methods

Market timing

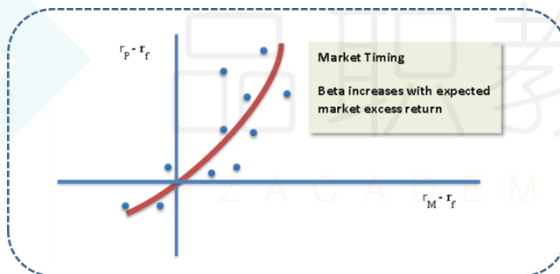
Case 1: No Market Timing

$$r_p - r_f = a + b(r_M - r_f)$$



Case 2: Treynor and Mazuy Model

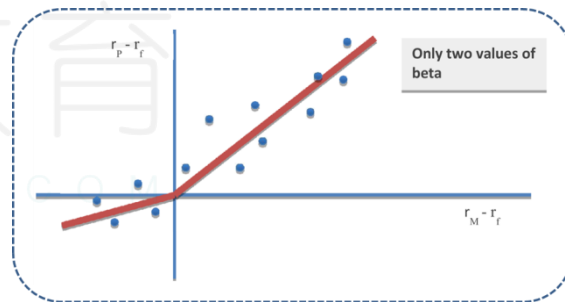
$$r_p - r_f = a + b(r_M - r_f) + c(r_M - r_f)^2 + e_p$$



$C > 0$, good timing

Case 3: Henriksson and Merton Model

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



$D = 1$, bull market
 $C > 0$, good timing

Call Option Model

the returns to the calls + bills portfolio are identical to the 100% perfect foresight returns. Therefore, the value or appropriate *fee for perfect foresight* should equal to the *price of the call option* on the market index

Style Analysis

Style { Value
Growth

Style { Large
Small



The goal of style analysis is to determine the investment behavior of a fund manager by finding the best asset class exposures in his portfolio.

Performance Attribution Procedures

- identify the **sources of value addition** to the portfolio.
- attributable to the
 - selection of the right **asset classes (sectors)**
 - selection of right **securities** within an asset class.



Statistical Significance Of A Performance Measure

- t-test {
- **Null (H0):** True alpha is zero.
 - **Alternative (Ha):** True alpha is not zero

$$t = \frac{\alpha - 0}{\sigma / \sqrt{N}} \rightarrow \sigma / \sqrt{N} \text{ Standard error of alpha estimate}$$



Difficulties In Measuring Hedge Funds Performance

- **quickly change** investment strategy
- **illiquid assets** that are difficult to price
- provide profits over a long period of time, but expose the fund to infrequent losses
- Survivorship bias



Section 5



PORTFOLIO CHOICE WITH ILLIQUID ASSETS

Portfolio Choice With Illiquid Assets

Characteristics Of Illiquid Markets

- **Most asset classes** are illiquid.
- Markets for illiquid assets are **large**.
- Illiquid assets comprise the **bulk** of most investors' portfolios.
- Liquidity **dries up** even in **liquid** asset markets.



Illiquidity arises due to following market imperfections

- Clientele effects and participation costs
- Transaction costs
- Search frictions
- Asymmetric Information
- Price impact
- Funding constraints

Three key biases

Survivorship bias

- the tendency of **poorly** performing funds to **stop reporting**.
- **remove survivorship bias is to observe entire population of funds**
- In illiquid asset markets we **never observe the full universe**.

Infrequent Sampling

- estimates of risks are **too low** when computed using **reported returns**.

Selection Bias

- Sample selection bias results from the tendency of **returns** only to be observed when underlying **asset values are high**.
- **Distressed companies** are usually not formally liquidated, and these “**zombie**” companies are often left as shell companies.



获得流动性风险溢价

Harvesting Illiquidity Risk Premiums

- By setting a *passive allocation to illiquid asset classes*, like real estate.
- By choosing securities within an asset class that are *more illiquid*, that is by engaging in liquidity security selection.
- By acting as a market maker at the *individual security level*.
- By engaging in *dynamic strategies* at the *aggregate portfolio level*.



Economic theory states that there should be a *premium* for *bearing illiquidity risk*

view is *flawed*

原因

- Illiquidity biases
- There is no “market index” for illiquid asset classes
- Cannot separate factor risk from manager skills



如果决定投资流动性差资产

Two Important Aspects Of Illiquidity



The major impacts of infrequent trading on asset allocation

- Large transaction *costs*
- *long times* between trading

- Illiquidity markedly reduces optimal holdings
- Rebalance Illiquid Assets to Positions Below the Long-Run Average Holding
- Consume Less with Illiquid Assets
- There Are No Illiquidity “Arbitrages”
- Investors Must Demand High Illiquidity Hurdle Rates



Section 6



HEDGE FUNDS

Hedge Funds

Introduction

Hedge funds vs. mutual funds

- **Private** versus public
- Ability to take **short positions**
- Freedom to use **high leverage**
- Ability to employ **derivatives**

基金经理技能

历史表现

Biases In Databases Of Hedge Funds

- Measurement Bias
- Backfill Bias
- Selection Bias(self-reporting bias)
- Survivorship Bias

行业发展

- Institutional investors are sophisticated.
- risk management, investment process, operational governance improved.
- creation of benchmarking indices

机构投资者作用

hedge fund manager's skill set

- An ability to **identify profitable** long as well as short opportunities in a range of asset categories
- The organizational structure to carry **short positions** for extended periods of time
- The know-how to fund **leveraged positions**
- The risk management skill to **maintain complex positions** during volatile markets

Biases In Databases Of Hedge Funds

- Early Days, 1987-1996
 - Hedge funds **easily outperformed the SNP** index
 - Survivorship and selection biases
- Collapse of Long Term Capital Management in Fall of 1998
 - The collapse of **LTCM** had a dramatic impact on the **private world of hedge fund investors**.
 - There is a **significant reduction in investor**
- Rapid Expansion, 2000-
 - **burst of the dot-com bubble**.
 - **Arrival of Institutional Investors**

Hedge Fund Strategies

Strategy	Details
Managed futures	<ul style="list-style-type: none">Managed futures fund managers tend to employ systematic trading programs that largely rely upon historical price data and market trends. A significant amount of leverage is often employed since the strategy involves the use of futures contracts.CTAs tend not to have a particular bias towards being net long or net short in any particular market
Global macro	<ul style="list-style-type: none">typically focus on identifying miss-pricings in equity, currency, interest rate and commodity markets.top-down global approachflexibility to use a broad investment mandate.These approaches may be systematic trend-following models, or discretionary in nature
Risk arbitrage (aka, Merger Arbitrage)	<ul style="list-style-type: none">typically attempt to capture the spreads in merger or acquisition transactionsLong Target, Short acquirerThe principal risk is usually deal risk
Fixed Income Arbitrage	<ul style="list-style-type: none">attempt to generate profits by exploiting inefficiencies and price anomalies between related fixed income securities

Strategy	Details
Convertible Arbitrage	<ul style="list-style-type: none"> • <i>long</i> positions of <i>convertible</i> and <i>short</i> the <i>underlying stock</i> • creating profit opportunities <i>irrespective of market moves</i>.
Long/Short Equity	<ul style="list-style-type: none"> • invest in both long and short sides of equity markets • have the <i>flexibility to shift investment styles</i>
Dedicated Short Bias	<ul style="list-style-type: none"> • take <i>more short positions than long positions</i> • <i>focus on companies with weak cash flow</i>
Emerging Markets	<ul style="list-style-type: none"> • Emerging markets funds typically invest in currencies, debt instruments, equities and other instruments of developing countries' markets (typically measured by GDP per capita). These countries are generally considered to be transitioning toward developed status.
Equity Market Neutral strategy	<ul style="list-style-type: none"> • Their returns can differ dramatically across different months. It appears to us that equity market neutral <i>does not behave like a single niche strategy</i>. • Return behavior suggests that different funds apply different trading strategies with a similar goal of achieving almost <i>zero beta(s)</i> against a broad set of equity indices.



Section 7



**PERFORMING DUE DILIGENCE ON SPECIFIC MANAGERS
AND FUNDS**

Performing Due Diligence

Reasons For The Failures Of Funds

- Poor investment decisions.
- Fraud
- Extreme events
- Excess leverage
- Lack of liquidity
- Poor controls
- Insufficient questioning
- Insufficient attention to returns.

➡ Due Diligence

- Questions To Evaluate A Manager
- Criteria To Assess Risk Management Process
- Operational Due Diligence
- Business Model Risk And Fraud Risk

尽职调查四大方面，了解

P Z A C A D E M Y . C O M

*Thank
You!*

