Risk Management and Investment Management

FRM二级培训讲义-基础班

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Topic Weightings in FRM Part II

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Framework

Risk Management and Investment Management

- Factor Investing
- Portfolio Construction
- Portfolio Risk Measures
- Portfolio Risk Management
- Performance Measurement and Evaluation
- Hedge Funds

Reading 1

Factor Investing

Framework

1. Factory Theory
2. Factors
3. Alpha (and the Low-Risk Anomaly)

Factory Theory

Factor Investing

Factor Theory

- **There are many similarities between food and assets, for example:**
  - Five macronutrients—water, carbohydrates, protein, fiber, and fat—for an "average" male, female, and child.
  - Three major risk factors are the driving force behind assets' risk premiums —market risk, credit risk and operational risk factors.

  - All Food contains different types of nutrients and the more expensive the nutrients, the higher the price of the food.
  - All assets have different exposures to the market factor and the greater the exposure, the higher the risk premium.

  - Nutrients can be cheap or expensive under certain circumstance.
  - Assets have different payoffs during high or low inflation periods or during economic recessions and expansions, in other words, risk premiums can be cheap or expensive under certain circumstance.

The Theory of Factor Risk Premiums

- **In summary, there are three similarities between food and assets:**
  - Factors matter, not assets.
  - Assets are bundles of factors.
  - Different investors need different risk factors.
- There is one difference, however, between factors and nutrients. Nutrients are inherently good for you. **Factor risks are bad.**

Factor Risk and CAPM

- The **factor theory** is trying to explain the phenomenon:
  - Investors exposed to losses during bad times are compensated by risk premiums in good times.
- **The basic intuition of the CAPM still holds true:**
  - That the factors underlying the assets determine asset risk premiums and that these risk premiums are **compensation for investors' losses during bad times.**

Implications of CAPM

- **Lessons learnt form CAPM:**
  - Don't hold an individual asset, hold the factor(the market risk premium)
  - Each investor has his own optimal exposure of factor risk(CAL and CML)
  - The average investor holds the market(MVE=market portfolio)
  - The factor risk premium has an economic story
    - ✓ $E(R_m) - R_f = \bar{\lambda}\sigma_m^2$, which indicated that risk premium should be compensated by average risk aversion or the variance of the market
  - Risk is factor exposure(beta matters how much the risk is to be taken)
  - Assets paying off in bad times have low risk premiums, in some circumstance, they are also defined as valuable assets such as gold.

Shortcomings of CAPM

- **There are seven major shortcomings of CAPM**
  - Investors only have financial wealth.
  - Investors have mean-variance utility.
  - Investors have single period investment horizon.
  - Investors have homogeneous (identical) expectations.
  - Market are frictionless.
  - All investors are price takers.
  - Information is free and available to everyone.

Multifactor Model

- Multifactor models recognize that bad times can be defined more broadly than just bad returns on the market portfolio.
  - The first multifactor model was the arbitrage pricing theory (APT), developed by Stephen Ross (1976).
- It uses the word "**arbitrage**" because the factors cannot be arbitraged or diversified away—just like the single market factor in the CAPM.
- In equilibrium, investors must be compensated for bearing these multiple sources of factor risk.
  - While the CAPM captures the notion of bad times solely by means of low returns of the market portfolio, each factor in a multifactor model provides its own definition of bad times.

Stochastic Discount Factors

- To capture the composite bad times over multiple factors, the new asset pricing approach uses the notion of a pricing kernel. This is also called a ***stochastic discount factor*** *(SDF)*.
- Just as the CAPM gives rise to assets having betas with respect to the market, multiple factors in the SDF gives rise to a multi-beta relation for an asset's risk premium:

$$E(r_i) = r_f + \beta_{i,1}E(f_1) + \beta_{i,2}E(f_2) + \cdots + \beta_{i,k}E(f_k)$$

  - where $\beta_{i,k}$ is the beta of asset i with respect to factor k and $E(f_k)$ is the risk premium of factor k.
    - ✓ For macro factors, f_1 could be inflation and f_2 could be economic growth, for example. Bad times are characterized by times of high inflation, low economic growth, or both.

Efficient Market Theory

- The "classical" notions of weak, semi-strong, and strong efficiency were laid out by **Fama** (1970) and are obsolete. Fama was awarded the Nobel Prize in 2013.
- In that year, the Nobel Prize committee also gave **Robert Shiller** the prize, representing the opposite viewpoint (nearly efficient) of behavioral, or non-rational, influences on financial markets.
- Grossman and Stiglitz develop a model in which markets are **near-efficient**. Active managers search for pockets of inefficiency, and in doing so cause the market to be almost efficient.
  - In these pockets of inefficiency, active managers earn excess returns **as a reward** for gathering and acting on costly information.

Why Inefficient

- **In a rational explanation**, high returns compensate for losses during bad times. This is the pricing kernel approach to asset pricing.
  - The key is defining those bad times and deciding whether these are actually bad times for an individual investor.
  - Certain investors, for example, benefit from low economic growth even while the majority of investors find these to be bad periods.
- **In a behavioral explanation**, high expected returns result from agents' under-or overreaction to news or events. Behavioral biases can also result from the inefficient updating of beliefs or ignoring some information.
- For some risk premiums, the most compelling explanations are rational (as with the volatility risk premium), for some behavioral (e.g., momentum), and for some others **a combination of rational and behavioral** stories prevails (like value/growth investing).

Example

- Market efficiency can be described with the efficient market hypothesis (EMH). Regarding the definition of EMH and the rational and behavioral explanations for this approach, the EMH suggests that:
  A. Speculative trading is costless.
  B. Active managers cannot generally beat the market.
  C. Under the behavioral explanation, losses during bad times are compensated for by high returns.
  D. Under the rational explanation, it is agents, under- or overreactions to news that generates high returns.

- **Correct Answer: B**

Example

- Which of the following statements least likely represents a limitation of the capital asset pricing model (CAPM)?
  - A. All investors are price takers.
  - B. Information is costless to obtain.
  - C. All investors have the same expectations.
  - D. There are uniform taxes and transaction costs.

- **Correct Answer: D**

Factors

Factor Investing

Factors

- **There are two types of factors.**
  - The first type is macro, fundamental-based factors, which include economic growth, inflation, volatility, productivity, and demographic risk.
  - The second type is investment-style factors like the market factor of the capital asset pricing model (CAPM). To be more specific, investment-style factors can be divided into
    - ✓ **Static factors**, like the market factor in CAPM, which we simply go long to collect a risk premium;
    - ✓ **Dynamic factors**, which can only be exploited through constantly trading different types of securities.

Macroeconomic Risk Factors

- Economic growth:
  - Risky assets generally perform poorly and are much more volatile during periods of low economic growth. However, **government bonds** tend to do well during these times.
- Inflation:
  - High inflation tends to be bad for both stocks and bonds. During periods of high inflation, all assets tend to do poorly. Part of the long-run risk premiums for both equities and bonds represents compensation for doing badly when inflation is high. The **exception** exists when it refers to commodities.

Macroeconomic Risk Factors

- Volatility:
  - The negative relation between volatility and returns is called the **leverage effect**. When stock returns drop, the financial leverage of firms increases since debt is approximately constant while the market value of equity has fallen. This makes equities riskier and increases their volatilities.
  - There is another channel where high volatilities lead to low stock returns: **an increase in volatility raises the required return on equity demanded by investors, also leading to a decline in stock prices.**

Mitigating Volatility Risk

- Investors who dislike volatility risk can buy volatility protection
  - **Buying volatility protection can benefit from increasing market volatility.**
- There are many ways to buy volatility protection
  - Buying or selling volatility protection can be done in option markets, but traders can also use other derivatives contracts, such as **volatility swaps**.
  - assets that pay off during high volatility periods, like **out-of-the-money puts**, provide hedges against volatility risk.
  - **Fixed income, currency, and commodity markets**, like the aggregate equity market, have a negative price of volatility risk.
    - ✓ Bonds offer some but not much respite during periods of high volatility, as the correlation between bond returns and VIX changes is only 0.12. Thus, **bonds are not always a safe haven** when volatility shocks hit.

Challenges to Manage Volatility Risk

- Investors who love volatility risk can sell volatility protection
  - Although selling volatility produces high and steady payoffs **during stable times**, once every decade or so, there is a **huge crash** where sellers of volatility experience large, negative payoffs.
  - Unfortunately, some investors who **sold volatility prior to the financial crisis** failed to anticipate that a crash like the one of 2008 would materialize.
  - Constructing valuation models with volatility risk can be tricky because the **relation between volatility and expected returns is time varying** and **switches signs** and is thus very hard to pin down.

Other Macroeconomic Risk Factors

- **Productivity Risk**
  - Shock to firm production, which occurs during the business cycles.
  - When productivity slows, stock return tends to be low.
- **Demographic Risk**
  - Shock to labor output.
  - Labor income is mostly earned and saved in young and middle age and dis-saved when retired.
- **Political Risk(sovereign risk)**
  - Mainly in emerging countries.
  - In financial crisis, developed countries have political risk as well.

Dynamic Risk Factors

- The best-known example of a tradeable multifactor model applied to present dynamic factors is introduced by **Fama and French.**
- The Fama–French (1993) model explains asset returns with three factors. There is the traditional CAPM market factor and there are two additional factors to capture a size effect and a value/growth effect:

$$E(r_i) = r_f + \beta_{i,MKT}E(r_m - r_f) + \beta_{i,SMB}E(SMB) + \beta_{i,HML}E(HML)$$

  - **SMB factor**, which refers to the differential returns of small stocks minus big stocks
  - **HML factor**, which stands for the returns of a portfolio of high book-to-market stocks minus a portfolio of low book to market stocks

Value and Size Investment Strategies

- **Size strategy is to go long small cap stocks and short large cap stocks**
  - The risk is that some small cap companies can be large cap companies eventually.
- **Value strategy is to go long value stocks and short growth stocks**
  - The risk of the value strategy is that although value outperforms over the long run, value stocks can underperform growth stocks during certain periods.
  - Value stock company has **high and asymmetric adjustment cost**.
    - ✓ In the bad time, value companies can hardly shift to more profitable activities, nor can they cut back on capital because they can't sell their specialized equipment.
    - ✓ However, growth companies can easily divest since they employ hotshot young employees and the great bulk of their capital is human capital.

Momentum Investment Strategies

- **Momentum** is the strategy of buying stocks that have gone up over the past six (or so) months (winners) and shorting stocks with the lowest returns over the same period (losers).
  - In 1993, **Jagadeesh and Titman** identified a momentum effect, which is then introduced by Carhart in his Four-Factor model.
  - The momentum effect refers to the phenomenon that winner stocks continue to win and losers continue to lose, just like "**Matthew Effect**".
  - Implementation of Momentum strategy
    - ✓ Price **rebounds in the short run.**
    - ✓ Price **eventually reverses** in the long run.
  - The cumulated profits of momentum has been significantly larger than that of size or value strategies.

Value and Momentum Investment Strategies

- **Same**:
  - The momentum strategy, like size and value, is a **cross-sectional strategy**, meaning that it compares one group of stocks against another group of stocks in the cross section, rather than looking at a single stock over time.
- **Difference**:
  - Value is a **negative feedback strategy**, where stocks with declining prices eventually fall far enough that they become value stocks.
  - Momentum is a **positive feedback strategy**. Stocks with high past returns are attractive, momentum investors continue buying them, and they continue to go up!

Example

- Which of the following concepts would least likely meet the definition of a factor?
  - A. Market.
  - B. Volatility.
  - C. Hedge funds.
  - D. Momentum investing style.

- **Correct Answer: C**

Alpha (and the Low-Risk Anomaly)

Factor Investing

Ideal Benchmark

- **Well defined**
  - The **identities** and **weights** of securities or **factor exposures** constituting the benchmark are **clearly defined**. eg. The Russell 1000 is verifiable and free of ambiguity about its contents.
- **Tradeable**
  - The benchmark should be a **realistic**, **low-cost alternative** for the asset owner. The benchmark's return is **readily calculable** on a **reasonably frequent basis**. eg. The Russell 1000 is a natural passive benchmark because low-cost mutual fund and ETF versions are available.
- **Replicable**
  - The benchmark is **consistent with the manager's investment style or area of expertise.** Nonreplicable benchmarks make it difficult or impossible to measure how much value a portfolio manager has added because the benchmark itself cannot be achieved by the asset owner.
- **Adjusted for risk**
  - Failing to adjust the benchmark for risk can make a huge difference in the alpha, a sound benchmark should be **reflective of the manager's current investment opinions.**

Impact of Benchmark Choice on Alpha

- **Failing to adjust the benchmark for risk can make a huge difference in the alpha!**
  - Example:
    - ✓ Take the R1000 index as a benchmark to get an alpha=0.0150

$$r_t = 0.0150 + r_t^{R1000} + \varepsilon_t$$

    - ✓ Take the combination of R1000 and risk free asset to get an alpha=0.0344

$$r_t = 0.0344 + 0.2728 r_t^{f} + 0.7272 r_t^{R1000} + \varepsilon_t$$

Further Study: Factor Regression

- **The first approach:** Estimate the risk-adjusted factor benchmark
  - CAPM Benchmark

$$r_{it} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + \varepsilon_{it}$$

  - Size and Value-Growth Benchmarks

$$r_{it} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + sSMB_t + hHML_t + \varepsilon_{it}$$

  - Adding Momentum

$$r_{it} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + sSMB_t + hHML_t + uUMD_t + \varepsilon_{it}$$

Further Study: Factor Regression

- **The second approach:** Mimic portfolio
  - Without risk free asset: A benchmark is a passive portfolio of index funds in stocks and bonds

$$r_{it} = \alpha + \beta_s r_{st} + \beta_b r_{bt} + \varepsilon_{it}$$

  - Adding real estate

$$r_{it} = \alpha + \beta_{REIT} REIT_t + \beta_s r_{st} + \beta_b r_{bt} + \varepsilon_{it}$$

Application of Factor Regression

- **Style analysis** is a factor benchmark where the factor exposures evolve through time. Style analysis seeks to rectify two potential shortcomings of our analysis so far:
  - Fama-French Model can reflect ones investment style, but the Fama–French portfolios are not tradeable.
  - The factor loadings may vary over time.
- **Style analysis** tries **to replicate** the fund by investing passively in low-cost index funds. The collection of index funds that replicate the fund is called the "style weight." **The changes in style weights reflect changes in investment styles**.

Style Analysis

- **To illustrate, let's take the following index ETFs**
  - SPY: SPDR S&P 500 ETF, which is designed to mimic the S&P 500;
  - SPYV: SPDR S&P 500 Value ETF, which tracks the S&P 500 value index; and
  - SPYG: SPDR SP& 500 Growth ETF, which replicates the S&P 500 growth index.
- **The style analysis can be demonstrated through two ways**
  - Style Analysis with No Shorting
  - Style Analysis with Shorting

Style Analysis

- **Style Analysis with No Shorting**

$$r_{t+1} = \alpha_t + \beta_{SPY,t} SPY_{t+1} + +\beta_{SPYV,t} SPYV_{t+1} + \beta_{SPYG,t} SPYG_{t+1} + \varepsilon_{t+1}$$

$$\beta_{SPY,t} + \beta_{SPYV,t} + \beta_{SPYG,t} = 1$$

$$\beta_{SPY,t}, \beta_{SPYV,t}, \beta_{SPYG,t} > 0$$

- **Style Analysis with Shorting**

$$r_{t+1} = \alpha_{i,t} + \beta_{SPY,t} SPY_{t+1} + (1 - \beta_{SPY,t}) r_{f,t+1} + h_t (SPYV_{t+1} - SPYG_{t+1}) + \varepsilon_{t+1}$$

  - The SPYV-SPYG is an investment that goes long the value SPYV ETF and simultaneously shorts the growth SPYG ETF**. Thus, it is analogous to the HML factor**.
  - The strong value bias is shown with a positive h loading on the SPYV-SPYG factor.

Alphas for Nonlinear Strategies

- Alphas are computed in a linear framework. There are many nonlinear strategies, especially those involving **dynamic option strategies,** that can masquerade as alpha.
- **There are two ways to account for nonlinear payoffs.**
  - Include Tradeable Nonlinear Factors
    - ✓ Nonlinear factors(volatility) can also be included in factor benchmarks. By doing so, the asset owner is assuming that she can **trade these nonlinear factors** by himself/herself.
  - Examine Non-tradeable Nonlinearities
    - ✓ Including nonlinear terms on the right-hand side of factor regressions.
      - ◆ Common specifications include quadratic terms, like r^2_t, or option-like terms like $\max(r_t, 0)$.
    - ✓ These will not be alphas, but they can still be used to rank managers and evaluate skill.

Low-risk Anomaly

- **The risky anomaly—**that stocks with low betas and low volatilities have high returns—appears to be a strong source of alpha relative to standard market-weighted benchmarks and value-growth, momentum, and other dynamic factors.
- **The low risk anomaly is a combination of three effects**
  - Volatility is negatively related with future returns
  - Realized beta is negatively related with future returns
  - Minimum variance portfolios do better than the market

Volatility Anomaly

- **Data evidence:**
  - Lagged Volatility and Future Returns(negative correlation)
  - Contemporaneous Volatility and Returns(negative correlation)
  - Lagged Beta and Future Returns(negative correlation but insignificant)
  - Contemporaneous Beta and Returns(positive correlation)
- **Conclusion**
  - Volatility and return: The most volatile stocks currently lose money (which we cannot forecast), and they also tend to lose money in the future as well (which is predictable).
  - Beta and return: The positive relationship is of little use cause we have such difficulty in predicting future betas, especially with past betas.

Risk Anomaly Explanations

- Data Mining
- Leverage Constraints
  - They can't borrow money and instead choosing to invest in high beta stocks
- Agency Problems
  - Many institutional managers have constraints against short selling, which allows mispricing to be existing.
- Preferences
  - If asset owners simply have a preference for high-volatility and high-beta stocks. Then they bid up these stocks until they have low returns. Conversely, these investors shun safe stocks—stocks with low volatility and low betas—leading to low prices and high returns for these shares.

Example

- Which of the following statements is not a characteristic of an appropriate benchmark? An appropriate benchmark should be:
  - A. Tradeable.
  - B. Replicable.
  - C. Well-defined.
  - D. Equally applied to all risky assets irrespective of their risk exposure.

- **Correct Answer: D**

Reading 2

Portfolio Construction

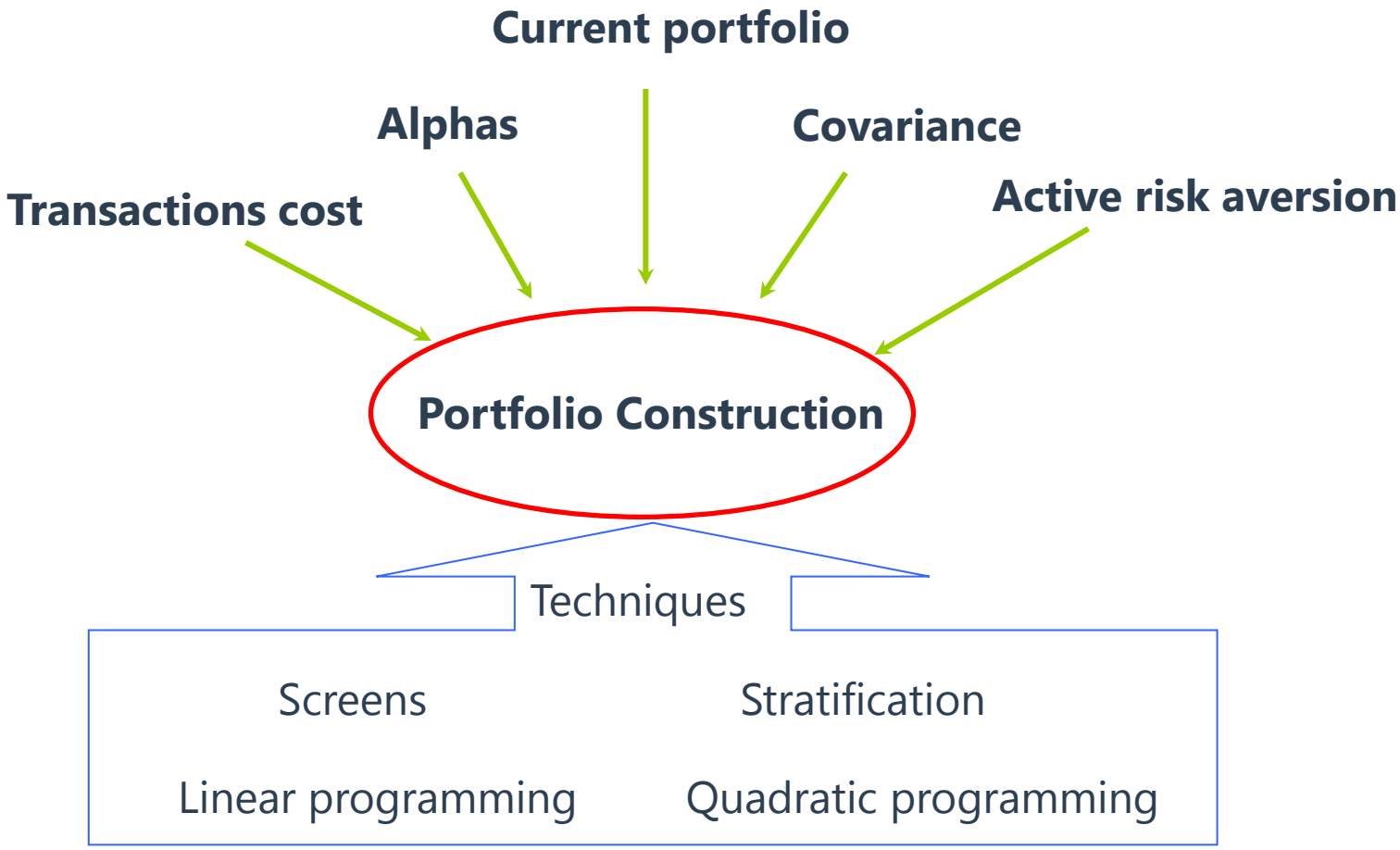
Framework

1. Portfolio Construction inputs
2. Portfolio Construction Techniques
3. Portfolio Revisions and Rebalancing
4. Dispersion

Portfolio Construction Inputs

Portfolio Construction

Inputs to the Portfolio Construction Process



Inputs to the Portfolio Construction Process

- **Portfolio construction requires several inputs:**
  - The current portfolio: of these inputs, we can measure only the current portfolio **with near certainty**.
  - Alphas
  - Covariance estimates
  - Transactions cost estimates
  - Active risk aversion: Most active managers will have a target level of active risk that we must make consistent with an active risk aversion.

Refining Alphas

- With alpha analysis, the alphas can be adjusted so that they are in line with the manager's desires for risk control and anticipated sources of value added.
  - Scale the alphas
  - Trim alpha outliers
  - Neutralization
    - ✓ Benchmark- and Cash-Neutral Alphas
    - ✓ Risk-Factor-Neutral Alphas

Scale the alphas

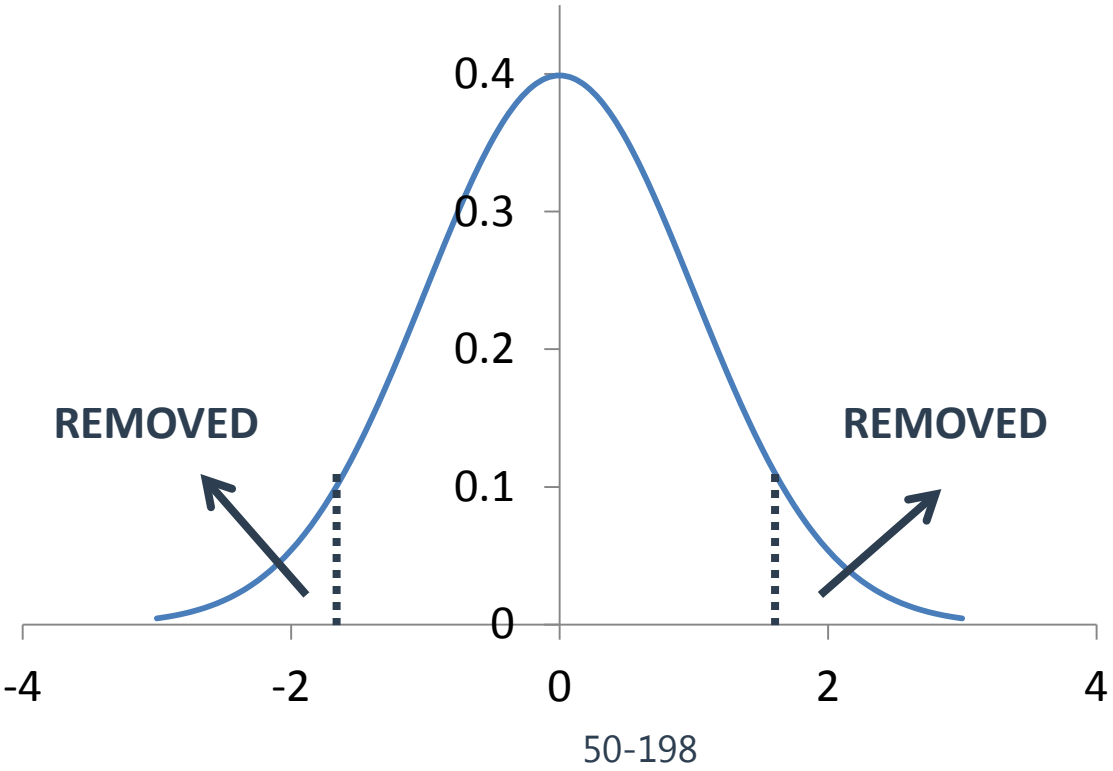
- **Alpha has a natural structure called Grinold Rule:**

$$\alpha = \sigma \times IC \times Score$$

  - IC is the information coefficient, which is the correlation of the manager's forecast with the actual returns (how good the forecasts are);
  - We expect the information coefficient (IC) and residual risk (volatility) for a set of alphas to be constant.
  - Score follows a standard normal distribution, hence the alphas should have mean of zero and standard deviation IC* residual risk.
  - **If the original unconstrainted alphas have volatility that is different with IC* residual risk, the alphas are scaled.**

Trim alpha outliers

- **The definition of the trim:**
  - Trim means removing the extreme outlier values.
  - The outliers can cause some difficulties in predicting the alphas.
  - An example can be described as follow:



Neutralization

- **Neutralization is to remove biases or undesirable bets from our alphas.**
  - Benchmark-Neutral Alphas
    - ✓ Means that the benchmark has **0 alpha**. If our initial alphas imply an alpha for the benchmark, the neutralization process recenters the alphas to remove the benchmark alpha.
    - ✓ **For example**, the alpha of benchmark and portfolio are 1% and 5%, respectively. The benchmark-neutral alpha for a portfolio with beta equals to 1.5 is 5%-1.5*1%=3.5%.
  - Cash-Neutral Alphas: the alphas will not lead to any active cash position.
  - Risk-Factor-Neutral Alphas
    - ✓ If the manager does not have any ability to forecast the risk factors, we can use risk-factor-neutral alphas. **Once neutralized, the alphas of the risk factors will be 0.**

Transactions Costs

- **Implications Transaction Costs have on Portfolio Construction**
  - Transactions costs force greater precision on our estimates of alpha.
  - Convert a one-dimensional problem (trade-off between alpha and active risk) into a two-dimensional problem (alpha, active risk, transaction costs).
  - Constructing, rebalancing and liquidating incur transaction costs.

Practical Issues

1. Determination of Risk Aversion

- If we have better intuition about our information ratio and our desired amount of active risk than our risk aversion
  - ✓ Utility = excess return – (risk aversion × variance)

$$\lambda_A = \frac{IR}{2 \times TEV}$$

- For example, if our information ratio is 0.5, and we desire 5% active risk, we should choose an active risk aversion of 0.05(ignore percentage). Furthermore, if the excess return is 2%, our maximum utility will be 2-0.05*5^2=0.75(percent)

Practical Issues

2. Incorporation of Specific Risk Aversion

- Aversion to specific as opposed to common-factor risk.
- Commercial optimizers utilize this decomposition of risk to allow **differing aversions to these different sources of risk**.
- Since specific risk arises from bets on specific assets, **a high aversion to specific risk** reduces bets on any one stock.

$$U = \alpha - (\lambda_{CF} \times TEV_{CF}^2 + \lambda_{SF} \times TEV_{SF}^2)$$

Practical Issues

3. Proper Alpha Coverage

- If we forecast returns on stocks that are not in the benchmark, we can always handle that by expanding the benchmark to include those stocks, albeit with zero weight.
- If there is a lack of forecast returns in the benchmark, adjust alphas to make benchmark neutral.

Example

- The most measurable of the inputs into the portfolio construction process is(are):
  - A. The position alphas.
  - B. The transaction costs.
  - C. The current portfolio.
  - D. The active risk aversion.

- **Correct Answer: C**

Portfolio Construction Techniques

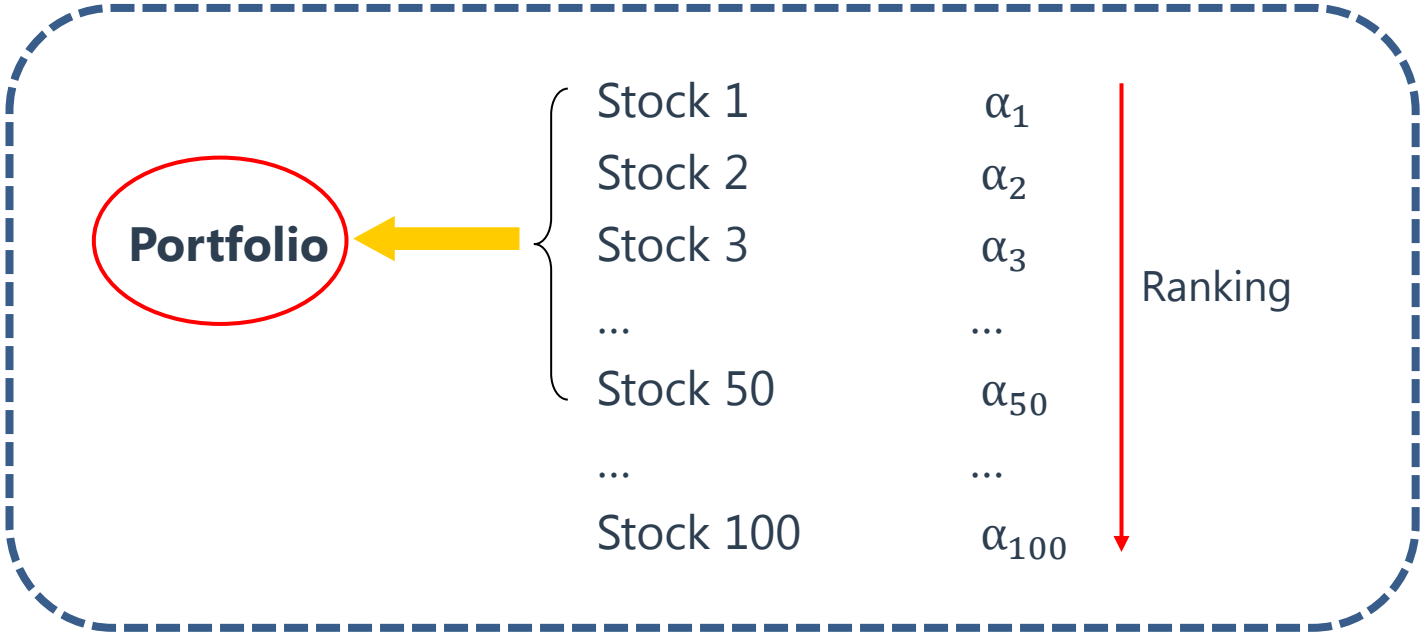
Portfolio Construction

Portfolio Construction Techniques

- **Four portfolio construction techniques**
  - Screens
  - Stratification
  - Linear programming
  - Quadratic programming

Portfolio Construction Techniques

- **Screens**
  - Rank the original 100 stocks by alpha.
  - Choose the first 50 stocks (for example).
  - Equal-weight (or capitalization-weight) the stocks



Portfolio Construction Techniques

- **Strength**
  - Easy to implement and understand.
  - It **enhances return** by selecting high-alpha assets and controls risk by having a sufficient number of assets for **diversification.**
  - Clear link between cause (membership on a buy/sell list) and effect (portfolio membership).
  - Robust in that **extreme estimates** of alpha will not bias the outcome.
- **Weakness**
  - **Ignores** all information in alphas aside from ranking. Do not protect against biases in alpha
  - **Excluding those categories** of assets that tend to have low alphas.

Portfolio Construction Techniques

- **Stratification**
  - Stratification is “glorified” screening.
  - Divide the stocks in categories (e.g., economic sectors, big/medium/small) and mimic the screening exercise.
- **Major strength over screens**
  - Ignoring biases in the alphas across categories.

Portfolio Construction Techniques

Linear Programming

- The linear programming approach characterizes stocks along dimensions of risk, e.g., **industry, size, volatility, and beta**.
- The linear program will then attempt to build portfolios that are reasonably close to the benchmark portfolio in all of the dimensions used for risk control.
- **Strength**
  - ✓ Takes all the information about alpha into account and controls tracking risk by keeping the characteristics of the portfolio close to the characteristics of the benchmark.
- **Weakness**
  - ✓ Has difficulty producing portfolios with a pre-specified number of stocks.
  - ✓ The risk-control characteristics may conflict with the alphas.

Portfolio Construction Techniques

- **Quadratic Programming**
  - **Ultimate** in portfolio construction
  - Explicitly considers all three elements: **alpha, risk, and transactions costs**.
  - Requires a great many more inputs than the other portfolio construction techniques. **More inputs mean more noise**.

Portfolio Revisions and Rebalancing

Portfolio Construction

Portfolio Revisions

- **Frequent revision or less frequent revision**
  - If a manager knows how to make the correct trade-off between expected active return, active risk, and transactions costs, frequent revision will not present a problem
  - If manager is unsure of ability to correctly specify alphas, active risk, and transactions costs, then may resort to less frequent revision as safeguard
  - Manager who underestimates transactions costs, makes large changes in alpha estimates very frequently, will result in the situation that has a lower expected alpha and higher transaction cost. **A crude but effective cure is to revise the portfolio less frequently.**

Portfolio Rebalancing

- **Decide whether to trade**

$$MCVA_n = \alpha_n - 2 \times \lambda_A \times \varphi \times MCAR_n$$

  - $MCVA_n$: Marginal contribution to value added for stock *n*
  - $MCAR_n$: Marginal contribution to active risk of asset n.
  - λ_A: risk aversion of investor
  - φ: active risk

- **Optimal No-Trade Region with transaction costs**
  - As long as the $MCVA_n$ stays within the negative cost of selling and the cost of purchase, the portfolio will remain optimal, and we should not react to new information.

$$-SC_n \leq MCVA_n \leq PC_n$$

Portfolio Rebalancing

The optimal alpha band

- In practice, there is a band around the alpha for each stock, as long as the alpha stays within a particular band, we should not make any changes.

$$2 \times \lambda_A \times \varphi \times MCAR_n - SC_n \leq \alpha_n \leq 2 \times \lambda_A \times \varphi \times MCAR_n + PC_n$$

✓ It is simplified when the problem only involves estimating alphas, risks, and transaction costs over time.

Example

- An increase in which of the following factors will increase the no-trade region for the alpha of an asset?

  I. Risk aversion.

  II. Marginal contribution to active risk.

  A. I only.

  B. II only.

  C. Both I and II.

  D. Neither I nor II.

- **Correct Answer: C**

Dispersion

Portfolio Construction

Dispersion

- **Introduction**
  - 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.
  - If the holdings in each account are identical, dispersion will disappear. If transactions costs were zero, dispersion would disappear.
- **Sources of Dispersion**
  - Client-driven: clients impose different constraints.
  - Lack of attention to separate accounts
- **Controlling Forms of Dispersion**
  - If transactions costs were zero, rebalancing all the separate accounts so that they hold exactly the same assets in the same proportions would have no cost. Dispersion would disappear, at no cost to investors.
  - With transactions costs, managers should reduce dispersion only until further reduction would substantially lower returns on average because much higher transactions costs would be incurred.

Reading 3

Portfolio Risk Measures

Portfolio VaR

- **Individual VaR**
  - This is the VaR of an individual position in isolation.
  - Where V is portfolio value and ω_i is the weight assigned to individual position, individual VaR is given by:

$$VaR_i = z_c\sigma_i|V_i| = z_c\sigma_i|\omega_i|V$$

- **Diversified VaR and Undiversified VaR**
  - Diversified VaR accounts for diversification effects. The two-asset variance is given by:

$$\sigma_p^2 = \omega_1^2\sigma_1^2 + \omega_2^2\sigma_2^2 + 2\rho\omega_1\omega_2\sigma_1\sigma_2$$

  - Undiversified VaR is simply the sum of the individual VaRs. If correlation <1, diversified VaR is less than Undiversified VaR.

Portfolio VaR

➢ **Example**

- An analyst computes the VaR for the two position in her portfolio. The VaR : VaR_1 = \$2.4million and VaR_2 = \$1.6million. Compute the VaR_p if the returns of the two assets are uncorrelated.
- **Answer: 2.88**

- An analyst computes the VaR for the two position in her portfolio. The VaR : VaR_1 = \$2.4million and VaR_2 = \$1.6million. Compute the VaR_p if the returns of the two assets are perfectly positive correlated.
- **Answer: 4**

Portfolio VaR

Marginal VaR

- The change in portfolio VaR resulting from taking an additional dollar of exposure to a given component. It is also the partial derivative with respect to the component position.

$$MVaR_A = \frac{\partial VaR_P}{\partial V_A}$$

$$= z_\alpha \times \frac{Cov(R_A, R_P)}{\sigma_P}$$

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

$$= z_\alpha \times \beta_{A,P} \times \sigma_P$$

$$= \frac{VaR_P}{V_P} \times \beta_{A,P}$$

Portfolio VaR

Incremental VaR

- Change in VaR owing to a new position.
- Differs from marginal VaR: amount added or subtracted can be large.
- Incremental VaR requires a **full revaluation** of the portfolio VaR with the new trade:

$$Incremental\ VaRA = VaR_{P+A} - VaR_P$$

- Approximate computation:

$$Incremental\ VaR_A \approx MVaR_A \times W_A(any\ amount)$$

Portfolio VaR

Component VaR

- In order to manage risk, it would be extremely useful to have a risk **decomposition** of the current portfolio.
- A partition of the portfolio VaR that indicates how much the portfolio VaR would change **approximately** if the given component was deleted.
- By construction, component VaRs sum to portfolio VaR.

$$CVaR_A = MVaR_A \times V_A$$

$$\frac{CVaR_A}{VaR_p} = \omega_A \times \beta_{A,P}$$

$$VaR_p = \sum_{i=1}^{N} CVaR_i = VaRp(\sum_{i=1}^{N} \omega_i \beta_{i,p})$$

$$\sum_{i=1}^{N} \omega_i \beta_{i,p} = 1$$

Portfolio VaR

- **Example 1**
  - A portfolio consists of assets A and B. There are $9 million and $1 million invested in them respectively. The covariance between A and this portfolio is 0.1468, and 0.0392 is the covariance between B and the portfolio. If we assume they are uncorrelated with each other, compute the **marginal VaR** of assets A and B; Assume a Z-score of 1.645, the variance of the portfolio is 0.136.
  - **Answer:**

$$MVaR_{\mathrm{A}} = Z_{\alpha} \times \frac{\mathrm{cov}(R_A, R_P)}{\sigma_P} = 1.645 \times \frac{0.1468}{\sqrt{0.136}} = 0.6548$$

$$MVaR_{B} = Z_{\alpha} \times \frac{\mathrm{cov}(R_B, R_P)}{\sigma_P} = 1.645 \times \frac{0.0392}{\sqrt{0.136}} = 0.1749$$

Portfolio VaR

- **Example 2**
  - Recall the example above of a portfolio invested \$9 million in A and \$1million in B. Using their respective marginal VaRs, 0.6548 and \$0.1749, compute the component VaRs.
  - **Answer:**

$$\mathrm{CVaR_A} = \mathrm{MVaR_A} \times (\mathrm{w_A} \times \mathrm{P}) = 0.6548 \times \$9\mathrm{million} = \$5{,}893{,}200$$
$$\mathrm{CVaR_B} = \mathrm{MVaR_B} \times (\mathrm{w_B} \times \mathrm{P}) = 0.1749 \times \$1\mathrm{million} = \$174{,}900$$

Applications of Portfolio VaR

- **How to minimize portfolio risk**
  - The portfolio manager can decrease portfolio risk by reducing positions with the highest marginal VaR.
  - Repeat process until the portfolio risk has reached a **global minimum**.
  - At this global risk minimum, all of the marginal VaRs must be equal, or all of the portfolio betas, must be equal to 1.

Applications of Portfolio VaR

- **How to balance between risk and return**
  - The role of a portfolio manager is to choose a portfolio that represents the best combination of expected risk and return.
  - The optimal portfolio has the highest Sharpe ratio:

$$SR = \frac{E(R_P) - R_f}{\sigma_P} \Rightarrow \frac{E(R_P) - R_f}{VaR_P}$$

  - In order to make this ratio maximized, we have:

$$\frac{Position\ i\ return\ -\ risk\ free\ rate}{MVaR_i} = \frac{Position\ j\ return\ -\ risk\ free\ rate}{MVaR_j}$$

Case Study

- **Case information:**
  - Consider a portfolio with two foreign currencies, 2 million Canadian dollar (CAD) and 1 million Euro (EUR).
  - Assume that these two currencies are uncorrelated and have volatility of 5% and 12% respectively.
  - In addition, the confidence level is 95%.
- **Question:**
  - A: Calculate the Marginal VaR, component VaR for each position.
  - B: If the portfolio manager wants to decrease portfolio risk by rebalance between the two asset, calculate the optimal weights assigned to each position.
  - C: If the expected returns for the two currencies are 8% and 5% respectively, how to adjust weights so that the portfolio will represent the best combination of expected risk and return.

Case Study

Calculation of Question A:

Currency	Currency Position	Volatility	Correlation Coefficient	Beta
CAD	2million	$\sigma_1 = 5\%$	$\rho_{1p} = \frac{Cov(R_1, R_p)}{\sigma_1 \sigma_p} = w_1 \frac{\sigma_1}{\sigma_p} = 0.64$	$\beta_1 = \frac{Cov(R_1, R_p)}{\sigma_p^2} = 0.61$
EUR	1million	$\sigma_2 = 12\%$	$\rho_{2p} = \frac{Cov(R_2, R_p)}{\sigma_2 \sigma_p} = w_2 \frac{\sigma_2}{\sigma_p} = 0.768$	$\beta_2 = \frac{Cov(R_2, R_p)}{\sigma_p^2} = 1.77$
Total	3million	$\sigma_p = 5.21\%$	Nil	Nil

Case Study

Calculation of Question A:

Currency	Individual VaR $\mathrm{VaR}_i = Z\sigma_i V_i$	Marginal VaR $\mathrm{MVaR}_i = \frac{\mathrm{VaR}_p}{V}\beta_i$	Component VaR $\mathrm{CVaR}_i = \mathrm{MVaR}_i V_i$	Percent Contribution $\beta_i \omega_i$
CAD	$165,000	0.0528	$105,630	41%
EUR	$198,000	0.1521	$152,108	59%
Undiversified VaR	$363,000	Nil	Nil	Nil
Diversified VaR	Nil	Nil	$257,738	100%

Case Study

➢ **Calculation of Question B:**

Asset	Original Position	Marginal VaR	Final Position	Marginal VaR	Beta
CAD	66.67%	0.0528	85.21%	0.0762	1.000
EUR	33.33%	0.1521	14.79%	0.0762	1.000
Total	100.00%		100.00%		
Diversified VaR	$257,738		$228,462		
Standard deviation	5.207%		4.615%		

Case Study

Calculation of Question C:

Risk and Return-Optimizing Position							
Asset	Expected Return E_i	Original Position w_i	Beta β_i	Ratio E_i/β_i	Final Position w_i	Beta β_i	Ratio E_i/β_i
CAD	8.00%	66.67%	0.615	0.1301	90.21%	1.038	0.0771
EUR	5.00%	33.33%	1.770	0.0282	9.79%	0.649	0.0771
Total	-	100.00%	-	-	100.00%	-	-
Diversified VaR	-	$257.738	-	-	$230.720	-	-
Standard Deviation	-	15.62%	-	-	13.98%	-	-
Expected Return	-	7.00%	-	-	7.71%	-	-
Sharpe Ratio	-	0.448	-	-	0.551	-	-

Example

- Consider the following two asset portfolios:

Asset	Position Value (in thousands of USD)	Return Standard Deviation (%)	Beta
A	400	3.60	0.7
B	600	8.63	1.2
Portfolio	1,000	5.92	1

Calculate the component VaR of asset A and marginal VaR of asset B, respectively, at the 95% confidence level.

A. USD 21,773 and 0.1306

B. USD 21,773 and 0.1169

C. USD 27,268 and 0.1169

D. USD 27,268 and 0.1306

- **Correct Answer：C**

Example

- A risk manager assumes that the joint distribution of returns is multivariate normal and calculates the following risk measures for a two-asset portfolio:

Asset	Position	Individual VaR	Marginal VaR	VaR Contribution
1	USD 100	USD 23.3	0.176	USD 17.6
2	USD 100	USD 46.6	0.44	USD 44.0
Portfolio	USD 200	USD 61.6		USD 61.6

What is β_2?

A. 0.714

B. 1.429

C. 1.513

D. Cannot determine from information provided

- **Correct Answer：B**

Example

- Suppose a portfolio consists of four assets. The risk contribution of each asset is as follows: UK large cap, 3.9%; UK small cap, 4.2%; UK bonds, 0.9%; non-UK bonds, 1.1%. Which of the following would not be a possible explanation for the relatively high risk contribution values for UK equities?
  - A. High expected returns on UK equities.
  - B. High weights on UK equities.
  - C. High volatilities of UK equities.
  - D. High correlation of UK equities with all other assets in the portfolio.

- **Correct Answer：A**

Example

- A portfolio has an equal amount invested in two positions, X and Y. The expected excess return of X is 9% and that of Y is 12%. Their marginal VaRs are 0.06 and 0.075 respectively. To move toward the optimal portfolio, what the manager would probably do:
  A. Increase the allocation in Y and/or lower that in X.
  B. Increase the allocation in X and/or lower that in Y.
  C. Do nothing because the information is insufficient.
  D. Not change the portfolio because it is already optimal.

- **Correct Answer：A**

Example

- Which of the following is true with respect to computing incremental VaR? Compared to using marginal VaRs, computing with full revaluation is:
  - A. More costly, but less accurate.
  - B. Less costly, but more accurate.
  - C. Less costly, but also less accurate.
  - D. More costly, but also more accurate.

- **Correct Answer：D**

Reading 4

Portfolio Risk Management

Framework

1. VaR Applications in Investment
2. VaR Applications to different risks

VaR Applications in Investment

Portfolio Risk Management

The three legged risk management stool

- **The risk plan**
  - The risk plan should be incorporated as a separate section of the organization's strategic planning document.
  - The risk plan should:
    - ✓ Set expected return and volatility (e.g., VaR and tracking error) goals for the relevant time period.
    - ✓ Define points of success or failure.
    - ✓ Paint a vision of how risk capital will be deployed to meet the organization's objectives.
    - ✓ help organizations define the bright line between those events that are merely disappointing and those that inflict serious damage.
    - ✓ Identify critical dependencies that exist inside and outside the organization.

The three legged risk management stool

- **The risk budgeting**
  - The risk budget—often called asset allocation—should **quantify** the vision of the plan.
  - The budget helps the organization stay on course with respect to its risk plan.
  - There are two types of risk budgeting
    - ✓ Budgeting across asset class
    - ✓ Budgeting across asset managers

Risk Budgeting

Budgeting across Asset Classes

- Process of allocating and managing risk using a top-down approach to different aspects of the investment process.
- Process intended to systematically allocate return volatility across portfolio components (asset class, managers, and/or securities) to maximize return at a targeted level of risk.
  - ✓ First, determine the total Value at Risk (VaR) which can be "budgeted" to the firm.
  - ✓ Second, choose the optimal allocation of assets given the total risk profile.

Example

- A manager has a portfolio with only one position: a $500 million investment in W. The manager is considering adding a $500 million position X or Y to the portfolio. The current volatility of W is 10%. The manager wants to limit portfolio VaR to $200 million at the 99% confidence level. Position X has a return volatility of 9% and a correlation with W equal to 0.7. Position Y has a return volatility of 12% and a correlation with W equal to zero. Determine which of the two proposed additions, X or Y, will keep the manager within his risk budget.

$$VaR_W = 2.33 \times 10\% \times 500 = 116.50million$$

$$VaR_X = 2.33 \times 9\% \times 500 = 104.85million$$

$$VaR_Y = 2.33 \times 12\% \times 500 = 139.80million$$

$$VaR_{W+X} = \sqrt{(116.5)^2 + (104.85)^2 + 2 \times 0.7 \times 116.5 \times 104.85} = 204million$$

$$VaR_{W+Y} = \sqrt{(116.5)^2 + (139.8)^2} = 182million$$

  - Y keeps the total portfolio within the risk budget.

Risk Budgeting

Budgeting across Active Managers

- The traditional method for evaluating active managers is by measuring their tracking error and using it to derive a measure known as information ratio. And the tracking error is the active return minus the benchmark return.

$$IR_i = \frac{\text{expected tracking error of the manager}}{\text{volatility of the manager's tracking error}}$$

$$IR_P = \frac{\text{expected tracking error of the portfolio}}{\text{volatility of the portfolio's tracking error}}$$

- The optimal allocation across managers is:

$$\text{weight of portfolio managed by manager } i = \frac{IR_i \times (\text{Portfolio's tracking error volatility})}{IR_P \times (\text{manager's tracking error volatility})}$$

Example

- (Cont.)The fund has an allocation of $60 million devoted to U.S. equities. Now the fund wants to allocate this $60 million to two managers so as to maximize the information ratio of the fund subject to an overall TEV of 4%. This is equivalent to a risk budget of $3.948 million. Each manager has a TEV of 6%. The fund managers have different capabilities, their IRs are 0.6 and 0.4, respectively. To achieve an exact TEV of 4%, the fund also need some residual investment in the benchmark, which has a TEV of zero.

	Inputs			Outputs	
	TEV	Information Ratio	Weight	Allocated Principal	Relative Risk Budget
Manager1	w_1=6%	IR_1=0.6	X_1=55%	60×0.55=33	1.645×6%×33 =3.2571
Manager2	w_2=6%	IR_2=0.4	X_2=37%	60×0.37=22.2	1.645×6%×22.2 =2.19114
Index	w_B=0%	IR_0=0	X_B=8%	60×0.08=4.8	0
Portfolio	w_P=4%	IR_P=0.72	100%	60	3.948

Risk Budgeting

- **Calculation Process:**

$$X_1 = \frac{IR_1/\omega_1}{IR_P/\omega_P} = \frac{0.6}{IR_P} \times \frac{4\%}{6\%}$$

$$X_2 = \frac{IR_2/\omega_2}{IR_P/\omega_P} = \frac{0.4}{IR_P} \times \frac{4\%}{6\%}$$

$$IR_P = \frac{E(e_P)}{\omega_P} = \frac{X_1E(e_1) + X_2E(e_2)}{\omega_P} = \frac{X_1E(e_1) + X_2E(e_2)}{4\%}$$

$$IR_1 = \frac{E(e_1)}{\omega_1} = 0.6 \rightarrow E(e_1) = 3.6\%$$

$$IR_2 = \frac{E(e_2)}{\omega_2} = 0.4 \rightarrow E(e_2) = 2.4\%$$

$$\downarrow$$

$$X_1 = 55\%, X_2 = 37\%, X_3 = 8\%$$

$$E(e_P) = X_1E(e_1) + X_2E(e_2) = 3.6\% \times 55\% + 2.4\% \times 37\% = 2.9\%$$

$$IR_P = \frac{E(e_P)}{\omega_P} = \frac{2.9\%}{4\%} = 0.72$$

Example

- The AT&T pension fund has 68%, or about $13 billion invested in equities. Assume a normal distribution and volatility of 15% per annum. The fund measures absolute risk with a 95%, one-year VaR, which gives $3.2 billion. The pension plan wants to allocate this risk to two equity managers, each with the same VaR budget. Given that the correlation between managers is 0.5, the VaR budget for each should be

  A. $3.2 billion

  B. $2.4 billion

  C. $1.9 billion

  D. $1.6 billion

- **Correct Answer: C**

Example

- The pension management analysts at Bing Inc. use a two-step process to manage the assets and risk in the pension portfolio. First, they use a VaR-based risk budgeting process to determine the asset allocation across for broad asset classes. Then, within each asset class, they set a maximum tracking error allowance from a benchmark index and determine an active risk budget to distribute among individual managers. Assume the returns are normally distributed. From the first step in the process, the following information is available.

	Expected Return	Volatility	Asset Allocation	Individual VaR	Marginal VaR
Small cap	0.2%	2.66%	35.0%	6,491	0.055
Large cap	0.15%	2.33%	40.0%	6,497	0.044
Commodities	0.10%	1.91%	16.7%	2,216	0.020
Emerging market	0.15%	2.70%	8.3%	1,570	0.047
	Total VaR:13,322				

Example

- Which of the following statements is/are correct?

I. Using VaR as the risk budgeting measure, the emerging markets class has the smallest risk budget.

II. If an additional dollar were added to the portfolio, the marginal impact on portfolio VaR would be greatest if it were invested in small caps.

III. As the maximum tracking error allowance is lowered, the individual managers have more freedom to achieve greater excess returns.

IV. Setting well-defined risk limits and closely monitoring risk levels guarantee that risk limits will not be exceeded.

A. I and II only

B. I,II,III and IV

C. II and III

D. I only

- **Correct Answer: A**

The three legged risk management stool

- **The risk monitoring**
  - Risk monitoring is required to ensure that material deviations from risk budget are detected and addressed in a timely fashion

VaR Application to Monitor risk

- **Passive and active allocations**
  - With a VaR system, investors can use this system to monitor their market risk better. This applied to both **passive and active allocations**.
  - **Passive allocations**
    - ✓ We can also call it benchmarking, however, it does not keep risk constant because the composition of the indices can change substantially.
  - **Active allocations**
    - ✓ Active portfolio management can change the risk profile of the fund.
    - ✓ In that case, VaR monitoring is a process to capture the reason why a sudden jump increase in the reported VaR of the fund. There are several explanations as follow:
      - ◆A manager taking more risk.
      - ◆Different managers taking similar bets.
      - ◆More volatile markets.

VaR Application to Monitor risk

- **VaR application**
  - Measures of marginal and component VaR can be used to identify where position changes will have the greatest effect on the total portfolio risk.
- **Limitation of the system**
  - Risk cannot be measured easily for some important asset classes such as real estate, venture capital, and some categories of hedge funds owing to illiquidity.
  - Other series may have very short histories, such as emerging markets, or none at all, such as initial public offerings.

Example

- Using VaR to monitor risk is important for a large firm with many types of managers because:
  A. It can help catch rogue traders and it can detect changes in risk from changes in benchmark characteristics.
  B. Although it cannot help catch rogue traders, it can detect changes in risk from changes in benchmark characteristics.
  C. Although it cannot detect changes in risk from changes in benchmark characteristics, it can help detect rogue traders.
  D. Of no reason. VaR is not useful for monitoring risk in large firms.

- **Correct Answer: A**

VaR Applications to different risks

Portfolio Risk Management

VaR Applications to Different Risks

- **VaR applications to different risks**
  - Absolute Risk vs. Relative Risk
  - Policy mix risk vs. active management risk
  - Funding Risk
  - Sponsor Risk

Measure Different Risks

- **Absolute Risk vs. Relative Risk**
  - The difference is whether the loss is measured relative to zero or a benchmark.
  - Absolute Risk: risk of a dollar loss over the horizon.
  - Relative Risk: the risk of a dollar loss relative to benchmark. Shortfall measured as dollar difference between the fund return and benchmark return. Relevant return is the tracking error (TE), which is excess return of asset over benchmark.

$$TE = R_P - R_B$$

$$TEV = \sigma(\mathrm{e}) = \sqrt{\sigma_P^2 - 2\rho\sigma_P\sigma_B + \sigma_B^2}$$

Measure Different Risks

- **Policy mix risk vs. active management risk**
  - The absolute risk can be broken down into two components, one is the **policy mix risk,** the other is **active management risk.**
    - ✓ **Policy mix risk:** the policy mix risk is the risk of a dollar loss owing to the policy mix selected by the fund.
    - ✓ **Active management risk:** the active management risk is the risk of a dollar loss owing to the total deviations from the policy mix.

Example

- The Ontario Teachers' Pension Plan Board (OTPPB) estimates that its annual VaR at the 99 percent level of confidence can be decomposed as follows (in percent of the initial fund value):

Source of Risk	VaR
Policy-mix VaR	19.6%
Active-mgt. VaR	1.6%
Asset VaR	19.3%

- **From the table, we can conclude that:**
  - Most of the risk is due to the policy mix.
  - Active management VaR is rather small, there may be two reasons:
    - ✓ the fund diversified with the benchmark or other managers.
    - ✓ the assets are invested in indexed or closely indexed funds.
  - Policy-mix VaR and active management VaR do not add up to the total-asset VaR, owing to diversification effect.

Risk Types

➢ Funding Risk

- The risk that assets values will not be sufficient to fund the liabilities.
- **Surplus** (S) is the difference between the value of the assets (A) and the liabilities (L).
  - ✓ The change in the surplus (△S) is equal to the change in assets (△A) minus the change in liabilities (△L).
- Funding risk should be measured as the potential shortfall in surplus over the horizon, this is sometimes called **surplus at risk(SAR)**.

$$\text{Expected surplus} = \mathrm{A} \times (1 + \mathrm{R_A}) - \mathrm{L} \times (1 + \mathrm{R_L})$$

$$\sigma_{\text{Surplus}} = \sqrt{\mathrm{A}^2{\sigma_\mathrm{A}}^2 + \mathrm{L}^2{\sigma_\mathrm{L}}^2 - 2\mathrm{A}\sigma_\mathrm{A}\mathrm{L}\sigma_\mathrm{L}\rho}$$

$$\textit{Surplus at risk} = z_\alpha \times \sigma_{Surplus}$$

Example

- An analyst reports the following fund information to the advisor of a pension fund that currently invests in government and corporate bonds and carries a surplus of USD 40 million:

Pension	Assets	Liabilities
Amount (USD million)	180	140
Expected annual growth	6%	10%
Modified duration	14	8
Annual volatility of growth	25%	12%

Example

- To evaluate the sufficiency of the fund's surplus, the advisor estimates the possible surplus values at the end of one year. The advisor assumes that annual returns on assets and the annual growth of the liabilities are jointly normally distributed and their correlation coefficient is 0.68. The advisor can report that, with a confidence level of 95%, the surplus value will be greater than or equal to:

  A. USD -58.2 million

  B. USD -22.0 million

  C. USD 1.0 million

  D. USD 21.0 million

- **Correct Answer: B**

Example

➢ **Explanation:**

- The lower bound of the 95% confidence interval is equal to: Expected Surplus – (95% confidence factor * Volatility of Surplus).
- The required variables can be calculated as follows:

$$\sigma_s = \sqrt{V_A^2 \times \sigma_A^2 + V_L^2 \times \sigma_L^2 - 2V_A \times V_L \times \sigma_A \times \sigma_L \times \rho_{A,L}}$$

$$= \sqrt{180^2 \times 0.25^2 + 140^2 \times 0.12^2 - 2 \times 180 \times 140 \times 0.25 \times 0.12 \times 0.68}$$

$$= 35.764$$

$$Expected\ Surplus = V_A \times (1 + R_A) - V_L \times (1 + R_L)$$

$$= 180 \times 1.06 - 140 \times 1.10 = USD36.80million$$

- Therefore, the lower bound of the 95% confidence interval = 36.80 – 1.645×35.764 = USD -22.032 million.

Measure Different Risks

- **Sponsor risk**
  - **The sponsor is the owner of the fund,** who is ultimately responsible for the pension fund.
  - **The sponsor risk** is measured both the movements in the assets, or even the surplus, and the ultimate effect on the economic value of the firm.
    - ✓ Cash-flow risk: is the risk of year-to-year fluctuations in contributions to the pension fund.
    - ✓ Economic risk: is the risk of variation in total economic earnings of the plan sponsor.
  - The pension-plan management should be integrated with the overall financial goals of the plan sponsor.

Example

- Which of the following statements about tracking error and value at risk (VaR) is least accurate?
  - A. Tracking error and VaR are complementary measures of risk.
  - B. Both tracking error and VaR may assume a normal distribution of returns.
  - C. Tracking error is the standard deviation of the excess of portfolio returns over the return of the peer group.
  - D. VaR can be defined as the maximum loss over a given time period.

- **Correct Answer: C**

Reading 5

Performance Measurement and Evaluation

119-198

Performance Measurement Framework

- Tool 1: The Green Zone
- Tool 2: The Sharpe and Information Ratios
- Tool 3: Alpha versus the Benchmark
- Tool 4: Alpha versus the Peer Group
- Tool 5: Attribution of Returns

Performance Measurement Framework

- **Tool 1: The Green Zone**
  - For prior week, month, year: calculate normalized returns (excess returns/tracking error) and tracking error.
  - Compare actual to target.
  - Policy decisions about **deviations**. (green/yellow/red)
    - ✓ **Green zone**: usual event with insignificant deviations.
    - ✓ **Yellow zone**: unusual event, but still is expected to occur with some regularity.
    - ✓ **Red zone**: truly unusual events and required immediate follow-up.

Performance Measurement Framework

- **Tool 2: The Sharpe and Information Ratios**
  - Can be used to measure relative performance vis à vis the competition; e.g., peer group comparisons.
  - They test whether the manager has generated sufficient excess returns to compensate for the risk assumed.

Return Calculation

- **Holding Period Return**

$$r_i = \frac{Total\ proceeds}{Initial\ investment} = \frac{Int(Div)Income + Capital\ gain}{Initial\ investment}$$

- **Time-Weighted Return**
  - Also known as the geometric average
  - It is not affected by cash flows during the investment periods

$$1 + r_G = [(1 + r_1)(1 + r_2)\ldots(1 + r_n)]^{1/n}$$

- **Dollar-Weighted Return**
  - Also Known as Internal rate of Return (IRR).
  - The rate of return at which the present value of cash inflows equals the present value of cash outflows.
  - Most suitable to show clients the performance of their own funds.

Example

- At T_0, a client invests $100,000 in a fund. By the end of the year, the value has risen to $105,000. Both time-weighted return and dollar-weighted return for the first year will be 5%.
- At T_1, the client invests $95,000 more in the fund. So, the portfolio manager has $200,000 to invest. By the end of second year (T_2), the portfolio value rises to $220,000. The TWR and DWR for the second year will be 10%. What is the annualized TWR and DWR for the 2-year period?

$$\text{TWR} = \sqrt{1.05 \times 1.10} - 1 = 7.47\%$$

$$DWR = \$100{,}000 + \frac{\$95{,}000}{(1+\text{r})} = \frac{\$220{,}000}{(1+\text{r})^2} \Rightarrow \text{r} = 8.24\%$$

- The annualized DWR is higher that TWR because the fund manager had more money to invest in the second year in which it earned a higher return.

Risk adjusted Return

- Evaluating performance based on average return alone is not very useful. Returns must be adjusted for risk before they can be compared meaningfully.
  - The simplest and most popular way is to compare rates of return with those of other investment funds with **similar risk characteristics**, which is called the **comparison universe**.
- **Adjusting returns for risk**
  - Total risk adjusted return
    - ✓ M^2 measure of performance
  - Systematic risk adjusted return
    - ✓ T^2 measure of performance
  - Unsystematic risk adjusted return
    - ✓ IR measure of performance

Risk-Adjusted Performance Measures

- **Sharpe Ratio** measures the excess return per unit of total risk.

$$SR = \frac{R_P - R_F}{\sigma_P}$$

- **Modigliani-Squared (M^2)**
  - Adjusting the portfolio such that its standard deviation is identical to that of the market portfolio.
  - The M^2 will then be the excess returns earned by the adjusted portfolio.

$$M^2 = \frac{\sigma_M}{\sigma_P}(R_p - R_f) - (R_M - R_f) = \sigma_M \times (SR_P - SR_M)$$

- M^2 is similar to Sharpe Ratio, but it is **a return and easy to understand**. It can be used to rank portfolios. The resultant rankings will be the same as with Sharpe Ratio.

Example

- **Calculate the M^2 measure for Portfolio P:**
  - Portfolio P mean return 10%
  - Portfolio P standard deviation 40%
  - Market portfolio mean return 12%
  - Market portfolio standard deviation 20%
  - Risk-free rate 4%

- **Answer:**

$$M^2 = \frac{\sigma_M}{\sigma_P}\left(E_{R_P} - R_f\right) - \left(E_{R_M} - R_f\right)$$

$$= \frac{20\%}{40\%}(10\% - 4\%) - (12\% - 4\%) = -5\%$$

Risk-Adjusted Performance Measures

- **Treynor Ratio** measures the excess return per unit of systematic risk.

$$TR = \frac{R_P - R_F}{\beta_P}$$

- **T^2**
  - Adjusting the portfolio such that its beta is identical to that of the market portfolio.
  - The T^2 is calculated If you subtract the market excess return from Treynor's measure

$$T^2 = \beta_M \times (TR_P - TR_M) = TR_P - (R_M - R_f)$$

- T^2 is similar to Treynor Ratio, but it is **a return and easy to understand**. It can be used to rank portfolios. The resultant rankings will be the same as with Treynor Ratio but may be different from that with Sharpe Ratio.

Risk-Adjusted Performance Measures

- **Information Ratio** measures the alpha per unit of unsystematic risk.

$$\text{IR} = \frac{\alpha}{\sigma_\alpha}, \text{or IR} = \frac{\text{excess return}}{\text{TE}}$$

  - Alpha is also called the abnormal return
  - unsystematic risk is also called residual risk, or tracking error
  - An ex-post measure of IR

Fundamental Law of Active Management

- **Information Ratio measures(Ex-ante)**

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

  - BR is the **breadth** of the strategy (how many bets are taken).
- **Limitations**
  - It ignore transactions costs, restrictions on trading, and other real-world considerations
  - It ignores downside risk and other higher moment risk while assuming that all information is used optimally.
  - A crucial assumption is that the forecasts are independent of each other.
- **Application**: When the fund manager optimally combined with the **benchmark portfolio** with original portfolio, the maximum improvement in the Sharpe measure will be determined by its information ratio

$$SR_p^2 = SR_B^2 + IR^2$$

Example

- Portfolio manager returns 10% with a volatility of 20%. The benchmark returns 8% with risk of 14%. The correlation between the two is 0.98. The risk-free rate is 3%. Which of the following statements is correct?

A. The portfolio has higher SR than the benchmark

B. The portfolio has negative IR

C. The IR is 0.35

D. The IR is 0.29

Correct Answer: D

Performance Measurement Framework

- **Tool 3: Alpha versus the Benchmark**
  - This tool regresses the excess returns of the fund against the excess returns of the benchmark.
  - The outputs of this regression are:
    - ✓ An intercept, often referred to as "**alpha**", or skill.
    - ✓ A slope coefficient against the excess returns of the benchmark, often referred to as "**beta**", or leverage.
- **Tool 4: Alpha versus the Peer Group**
  - This tool regresses the manager's excess returns against the excess returns of the manager's peer group.
  - This tool is used to determine whether the manager demonstrates skill over and above what is found in the peer group.

Risk-Adjusted Performance Measures

➢ Excess Return, Alpha and Jensen's Alpha

- Excess return is the difference between the portfolio and benchmark

$$\text{Excess return} = E(R_P) - E(R_B)$$

- Alpha is the intercept term of a regression model between the excess return of the portfolio and the excess return of the benchmark
  - ✓ Beta measures the leverage towards benchmark

$$R_P - R_F = \alpha + \beta[R_M - R_F] + \varepsilon$$

- Jensen's alpha calculates the returns of a portfolio in excess of the theoretical expected returns such as CAPM or APT

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

$$\alpha_P = E(R_P) - \left(R_F + \sum \beta_i \lambda_i\right)$$

Statistical Significance of Alpha

- **Alpha plays a critical role in determining portfolio performance.**
  - A positive alpha produces an indication of superior performance;
  - A negative alpha produces an indication of inferior performance;
  - zero alpha produces an indication of normal performance matching the benchmark.
  - In order to assess a manger's ability of generate alpha, we conduct a t-test under the following hypotheses:
    - ✓ H_0: True alpha is zero
    - ✓ H_A: True alpha is not zero

$$t = \frac{\alpha - 0}{se(\alpha)} = \frac{\alpha}{\sigma/\sqrt{N}}$$

Where

- ✓ α = alpha estimate;
- ✓ σ = alpha estimate volatility
- ✓ N = sample number of observations

Example

- Portfolio Q has a beta of 0.7, an expected return of 12.8%, and an market risk premium of 5.25%. The risk-free rate is 4.85%. Calculate Jensen's alpha measure for portfolio Q.

  A. 7.67%

  B. 2.70%

  C. 5.73%

  D. 4.27%

- **Correct Answer: D**

Example

- Assume that a hedge fund provides a large positive alpha. The fund can take leveraged long and short positions in stocks. The market went up over the period. Based on this information,
  - A. If the fund has net positive beta, all of the alpha must come from the market.
  - B. If the fund has net negative beta, part of the alpha comes from the market.
  - C. If the fund has net positive beta, part of the alpha comes from the market.
  - D. If the fund has net negative beta, all of the alpha must come from the market.

- **Correct Answer: C**

Example

- Risk Masler is considering the performance of the managers of two funds, the HCM Fund and the GRT Fund. He uses a linear regression of each manager's excess return (r_i) against the excess returns of a peer group (r_B):

$$r_i = a_i + b_i \times r_B + \varepsilon_i$$

Fund	Initial Equity	Borrowed Funds	Total Investment Pool	a_i	b_i
HCM	USD 100	USD 0	USD 100	0.0150 (t = 4.40)	0.9500 (t = 12.1)
GRT	USD 500	USD 3,000	USD 3,500	0.0025 (t = 0.02)	3.4500 (t = 10.20)

- Based on this information, which of the following statements is correct?

A. The regression suggests that both managers have greater skill than the peer group.

B. The αi term measures the extent to which the manager employs greater or lesser amounts of leverage than do his/her peers.

C. If the GRT Fund were to loss 10% in the next period, the return on equity (ROE) would be -60%

D. The sensitivity of the GRT fund to the benchmark return is much higher than that of the HCM fund.

Example

- Based on 60 monthly returns, you estimate an actively managed portfolio alpha=1.24% and standard error of alpha=0.1278%. The portfolio manager wants to get due credit for producing positive alpha and believes that the probability of observing such a large alpha by chance is only 1%. Calculate the t-statistic, and based on the estimated t-value would you accept (or reject) the **claim** made by the portfolio manager.

  A. t=9.70, accept

  B. t=2.66, accept

  C. t=2.66, reject

  D. t=9.70, reject

- **Correct Answer: A**

Example

- **Analysis of portfolio P and Q**

Performance Statistics			
	Portfolio P	Portfolio Q	Portfolio M
Sharpe Ratio	0.43	0.49	0.19
M^2	2.16	2.66	0.00
SCL Regression Statistics			
Alpha	1.63	5.26	0.00
Beta	0.70	1.40	1.00
Treynor	3.97	5.38	1.64
T^2	2.34	3.74	0.00
$\sigma(e)$	2.02	9.81	0.00
Information Ratio	0.81	0.54	0.00

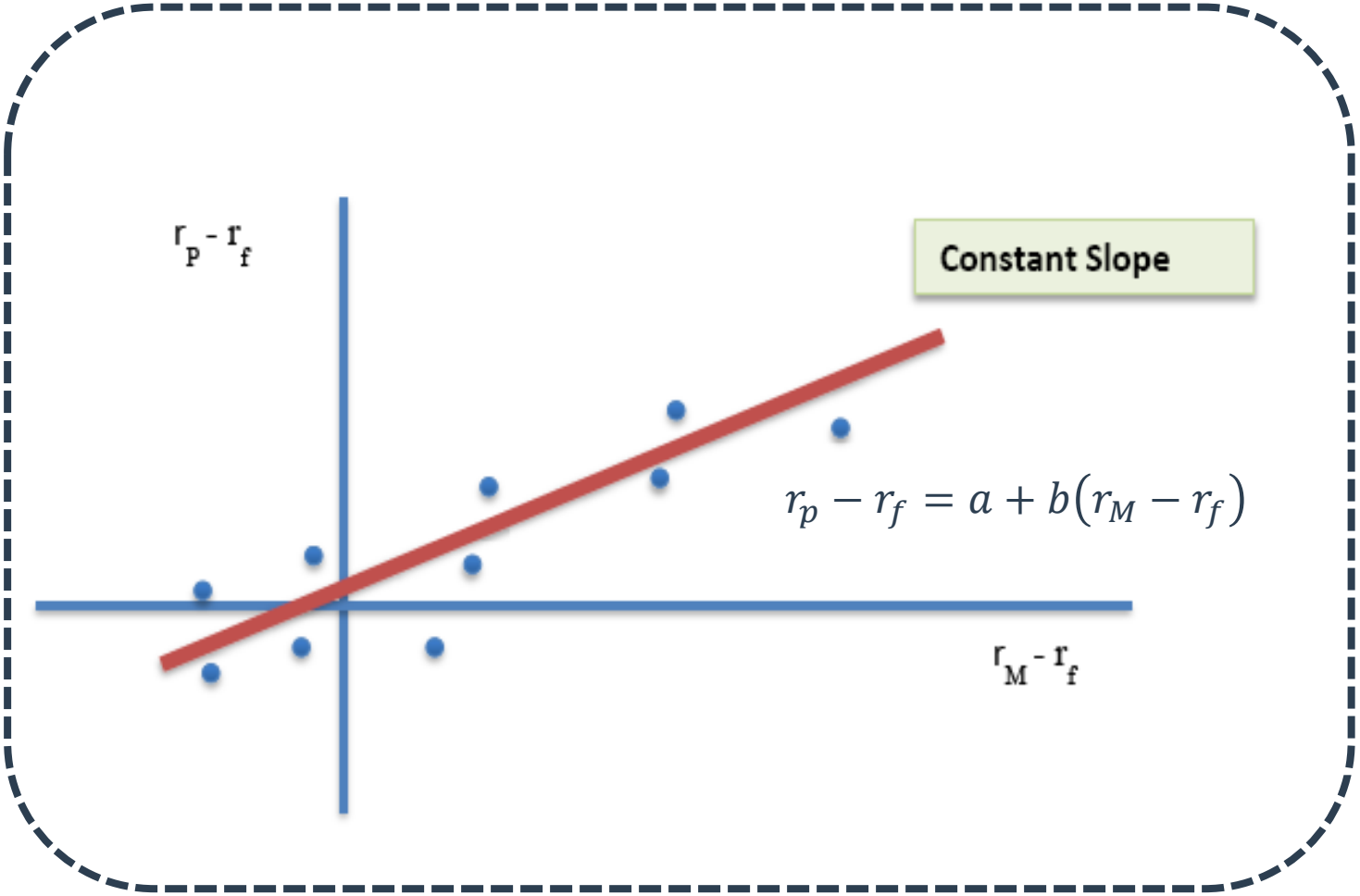
Performance Measurement Framework

- **Tool 5: Attribution of Returns**
  - A commonly used tool to measure the quality of returns is performance attribution.
  - This technique attributes the source of returns to individual securities and/or common factors.

Market Timing Ability

- **Market Timing**
  - The ability to predict the future direction of market and shifting funds between the market index portfolio and risk-free assets depending of whether the market will outperform the risk-free assets.
- **No Market Timing**
  - Assuming no market timing, and a constant beta, the security characteristic line will be straight line with a constant slope.

Market Timing Ability



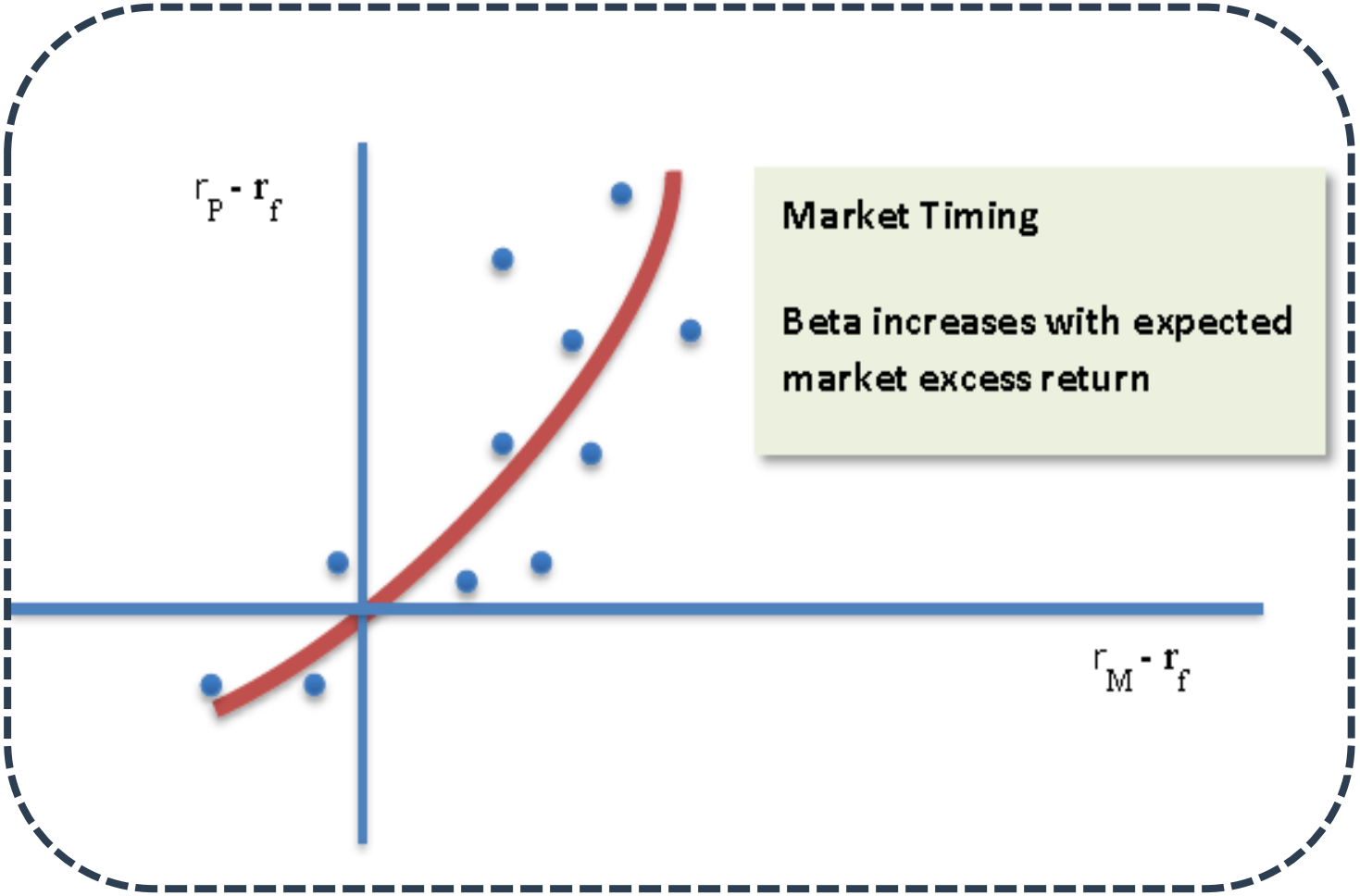
Market Timing Ability

- **Market Timing (Treynor and Mazuy)**
  - The investor is able to accurately time the market and is shifting the funds in to the market when it does well and withdraws and puts funds in safe assets when the market in going downwards.
  - As the market returns increase, the portfolio beta will also increase, resulting in a curved line.

$$r_P - r_f = a + b(r_M - r_f) + c(r_m - r_f)^2 + e_P$$

  - The squared term represents the market-timing factor. A positive c is an indication of the fund manager's timing ability.

Market Timing Ability



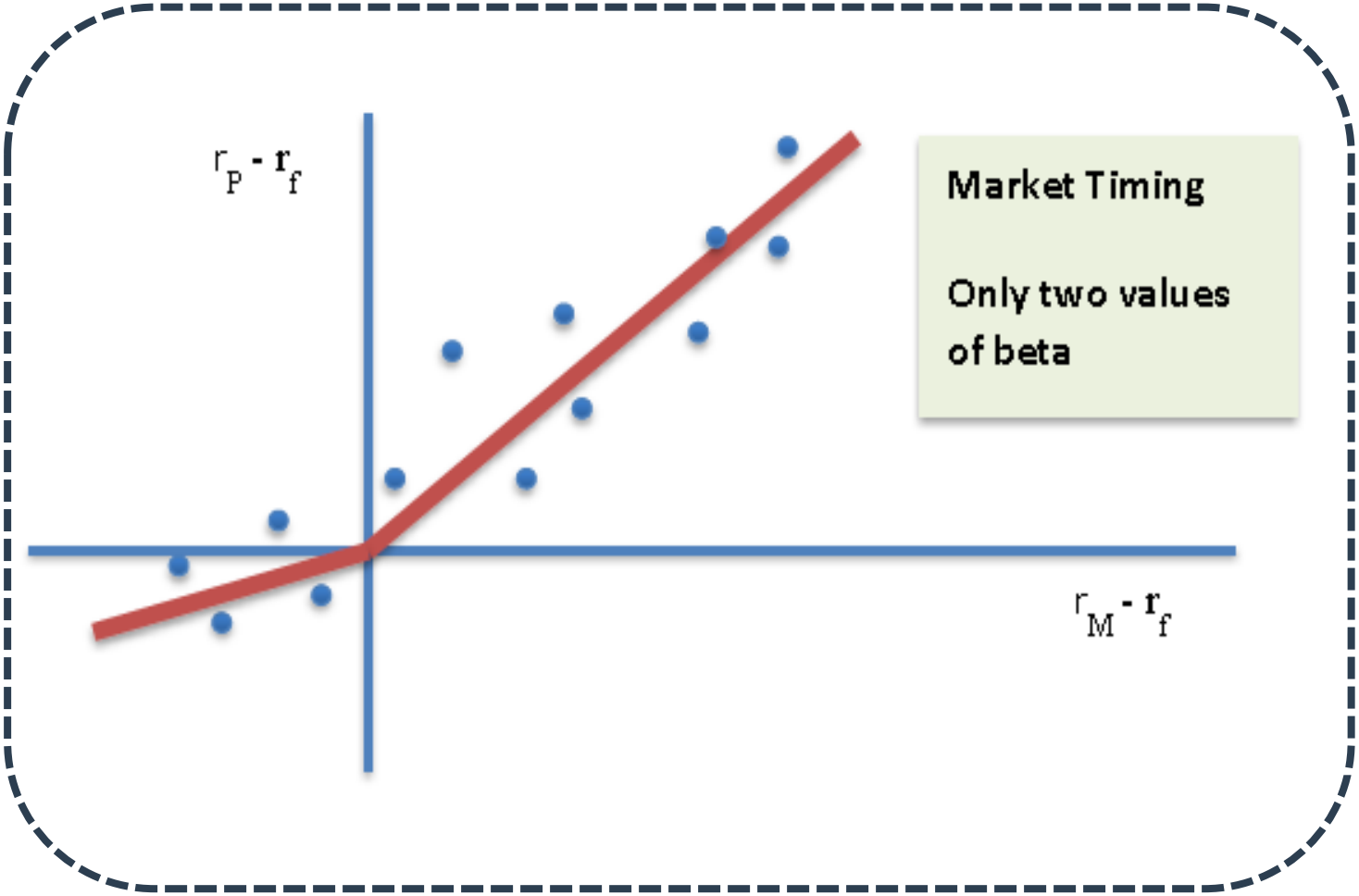
Market Timing Ability

- **Market Timing (Henriksson and Merton)**
  - This approach assumes that the beta of the portfolio can take only two values: a large value if the market is expected to do well, otherwise a smaller value.

$$r_P - r_f = a + b(r_M - r_f) + c(r_M - r_f)D + e_P$$

  - D is a dummy variable. D = 1 when $r_M > r_f$, otherwise D = 0.
  - The portfolio's beta is b in bear market and b + c in bull market. A positive c is an indication of the fund manager's timing ability.

Market Timing Ability



Value Market Timing Ability

Call Option Model

- The key to valuing market timing ability is to recognize that perfect foresight is equivalent to holding a call option on the equity portfolio.
  - ✓ The perfect timer invests 100% in either the safe asset or the equity portfolio, whichever will provide the higher return.
- To see the value of information as an option, suppose that the market index currently is at S_0 and that a call option on the index has an exercise price of $X = S_0(1+r_f)$.

	$S_T < X$	$S_T > X$
Bills	$S_0(1+r_f)$	$S_0(1+r_f)$
Option	0	$S_T - X$
Total	$S_0(1+r_f)$	S_T

  - ✓ The value or appropriate fee for perfect foresight should equal to the price of the call option on the market index.

Performance Attribution

- **Performance Attribution**
  - Identify the sources of value addition to the portfolio.
  - How much of the performance (excess returns above **bogey portfolio**) is attributable to the selection of the risk asset classes.
  - How much is attributable to selection of right sector or security within an asset class.

Example

- Let's assume that we have a benchmark portfolio with funds allocated in three asset classes namely, equity, bonds, and money markets. We also have a managed portfolio with assets allocated in the same asset classes with but a different composition.

	Managed Portfolio		Benchmark Portfolio	
	Weights	Performance	Weights	Performance
Equity	0.75	7.50%	0.50	6.00%
Bonds	0.10	2.00%	0.40	2.00%
Cash	0.15	0.50%	0.10	0.50%

Managed Portfolio Returns	0.75×7.5%+0.1×2%+0.15×0.5%	5.90%
Benchmark Portfolio Returns	0.50×6%+0.4×2%+0.1×0.5%	3.85%
Excess Returns		2.05%

Example

- Answers:

Contribution of Asset Allocation to Performance					
Market	Actual Weight	Benchmark Weight	Active/Excess Weight	Market Return	Contrib. to Perform.
Equity	0.75	0.50	0.25	6.00%	1.5000%
Bonds	0.10	0.40	-0.30	2.00%	-0.6000%
Cash	0.15	0.10	0.05	0.50%	0.0250%
Total					0.9250%

Contribution of Selection to Performance					
Market	Portfolio Perform.	Benchmark Perfom.	Excess Perform.	Port. Weight	Contrib.
Equity	7.50%	6.00%	1.50%	0.75	1.1250%
Bonds	2.00%	2.00%	0.00%	0.10	0.0000%
Cash	0.50%	0.50%	0.00%	0.15	0.0000%
Total					1.1250%

Example

- Assume you purchase a share of stock for $50 at time t = 0 and another share at $65 at time t = 1, and at the end of year 1 and year 2, the stock paid a $2.00 dividend. Also at the end of year 2, you sold both shares for $70 each. The dollar-weighted rate of return on the investment is:

  A. 10.77%

  B. 15.45%

  C. 15.79%

  D. 18.02%

- **Correct Answer: D**

Example

- Assume you purchase a share of stock for $50 at time t = 0 and another share at $65 at time t = 1, and at the end of year 1 and year 2, the stock paid a $2.00 dividend. Also at the end of year 2, you sold both shares for $70 each. The time-weighted rate of return on the investment is:

  A. 18.04%

  B. 18.27%

  C. 20.13%

  D. 21.83%

- **Correct Answer: D**

Reading 6

Hedge Fund

153-198

Framework

1. Introduction of Hedge Funds
2. Evolution of the Hedge Fund Industry
3. Hedge Fund Strategies
4. Risk Management of Hedge Fund
5. Due Diligence

Introduction of Hedge Funds

- **Hedge Funds versus Mutual Funds**
  - Private versus public
    - ✓ Historically, hedge funds are private investment vehicles not open to the general investment public.
    - ✓ Consequently, hedge funds face less regulation than publicly traded mutual funds.
  - Ability to take short positions
    - ✓ Typically hedge fund managers generate profit from both long as well as short positions.
  - Freedom to use high leverage
  - Ability to employ derivatives

Introduction of Hedge Funds

- **Basic Features**
  - To keep other traders from mimicking or “front running” their trades, they offer very little transparency, even to their investors.
  - A typical hedge fund charges a fixed management fee based on the value of assets they manage. The lower end of this range is comparable to the **management fees** charged by actively managed mutual funds. However, unlike mutual funds, hedge funds generally charge an **incentive fee** which are only payable when new profits are made. Sometimes, the incentive fee is paid after the performance exceeds a hurdle rate, such as LIBOR.

Example

- Assume that the Net Asset Value (NAV) goes from 100 to 120 over the year before fees (gross) and that LIBOR is at 5%. Fees are at the usual 2 and 20.
  - If LIBOR is the hurdle rate, the total fees is 100 × 2% + [(120 – 102) – 0.05 × 100] × 20%. In this case, the gross return is 20%, the total fees to the manager are 4.6%, and the net return is 15.4%.
  - Without the hurdle rate, the net return would be 14.4%.

Introduction of Hedge Funds

- **Hedge Fund Manager versus Institutional Investors**
  - Hedge Fund Manager
    - ✓ Is the best judge of the appropriate risk/reward trade-off of the portfolio; should be given broad discretion
    - ✓ Trading strategies are highly proprietary and must be jealously guarded lest they be reverse-engineered/copied
    - ✓ Return is the ultimate, often the only, objective
    - ✓ Risk management is not central to success of a hedge fund
    - ✓ Regulatory constraints and compliance issues are generally a drag on performance; the whole point of a hedge fund is to avoid these issues.
    - ✓ There is little intellectual property involved in the fund; the general partner is the fund.

Introduction of Hedge Funds

- Institutional Investors
  - ✓ As fiduciaries, institutions need to understand the investment process before committing to it.
  - ✓ Must fully understand the risk exposures of each manager; may have to circumscribe a manager's strategies to be consistent with the institution's investment objectives.
  - ✓ Performance is not measured solely by return. Other factors; e.g., risk, tracking error, peer comparisons.
  - ✓ Risk management and risk transparency are essential.
  - ✓ Operate in highly regulated environment
  - ✓ Desire structure, stability, and consistency in a well-defined investment process that is institutionalized and not dependent on any single individual.

Introduction of Hedge Funds

- **Bias in Hedge Fund Databases**
  - **Survivorship Bias**
    - ✓ Few hedge-fund databases maintain histories of funds that have shut down.
  - **Self-Selection Bias**
    - ✓ If a manager operates several hedge funds, it is questionable whether the poor performing ones will find their way into databases.
  - **Backfill Bias**
    - ✓ A related and important form is sometime referred to as the **"instant history"** bias.
    - ✓ When a new fund enters the database some of its performance history during its incubation period is incorporated without clear distinction from the live performance data going forward.

Example

- A significant percentage of hedge funds stop trading each year and drop out of hedge fund databases. Which of the following best describes the impact this has historically had on hedge fund analyses performed using these databases?
  A. The average performance of hedge funds is overstated.
  B. The average volatility of hedge funds is overstated.
  C. The average correlation of hedge fund returns is understated.
  D. The average Sharpe ratio of hedge fund returns is understated.

- **Correct Answer: A**

Example

- Every year, BusinessWeek reports the performance of a group of existing equity mutual funds, selected for their popularity. Taking the average performance of this group of fund will create
  - A. Survivorship bias only
  - B. Selection bias only
  - C. Both survivorship and selection bias
  - D. Instant-history bias only

- **Correct Answer: C**

Evolution of the Hedge Fund Industry

Hedge Funds

- Private partnership funds that have very few limitations on investment strategy and can take long and short positions in various markets.

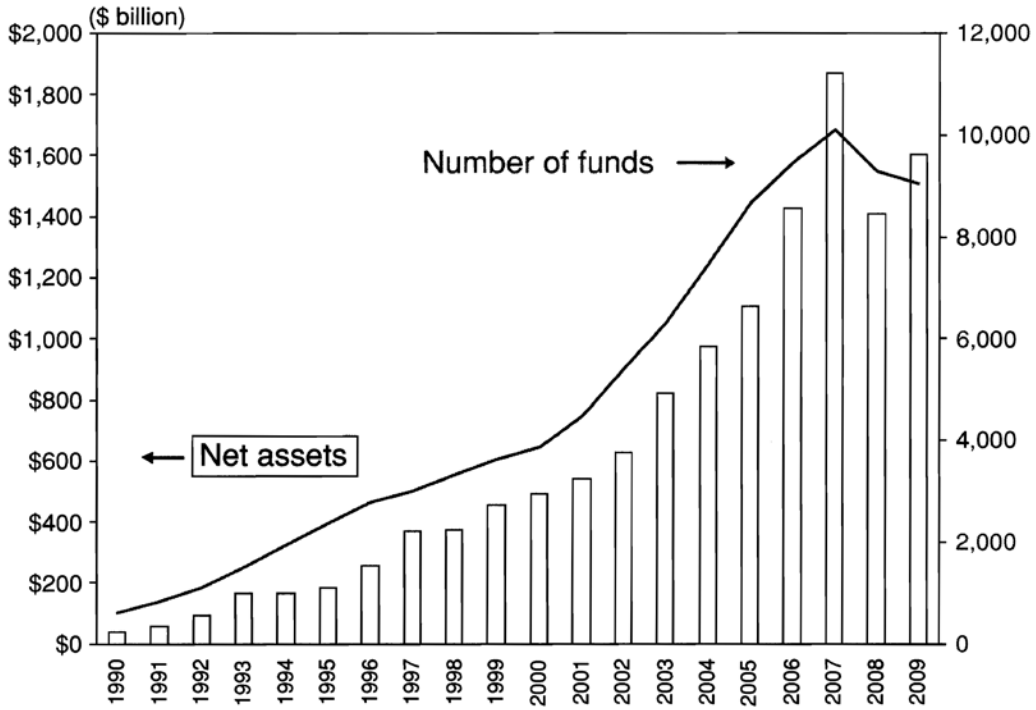


FIGURE 30.1 Growth of Hedge Fund Industry
Source: Hedge Fund Research. Data as of December of each year.

Evolution of the Hedge Fund Industry

- **Early Days, 1987-1996**
  - Hedge funds easily outperformed the S&P index by a wide margin
  - Survivorship and selection biases
- **Collapse of Long Term Capital Management in Fall of 1998**
  - The collapse of a large, well-known hedge fund like LTCM had a dramatic impact on the private world of hedge fund investors.
  - LTCM was a turning point in the capital formation process of the hedge fund industry. **There is a significant reduction in investors' appetite for hedge funds.** By the end of 1998, the hedge fund investment community had generally accepted that the first two moments of an expected return distribution may be woefully inadequate for capturing the risk of these dynamic, nonlinear, leveraged strategies.

Evolution of the Hedge Fund Industry

- **Rapid Expansion, 2000-**
  - The ensuing two year period, 2000-2001**, witnessed the burst of the dot-com bubble.**
  - For the first time since 1996, the cumulative performance of hedge funds exceeded that of the S&P index. Not only had hedge funds outperformed the S&P index, their return standard deviations were just over half of the S&P index's return standard deviation.
  - **Institutional investors' appetite for hedge funds improved**. Arrival of Institutional Investors (foundations, endowments, pension funds, and insurance companies, etc.)
  - By the end of 2007, the total Asset-Under-Management of the hedge fund industry had grown to $1,390 billion from $197 billion at the end of 1999. Taken together these observations are consistent with a shift in the investor clientele from an industry dominated by private wealthy investors to institutional investors.

Hedge Fund Strategies

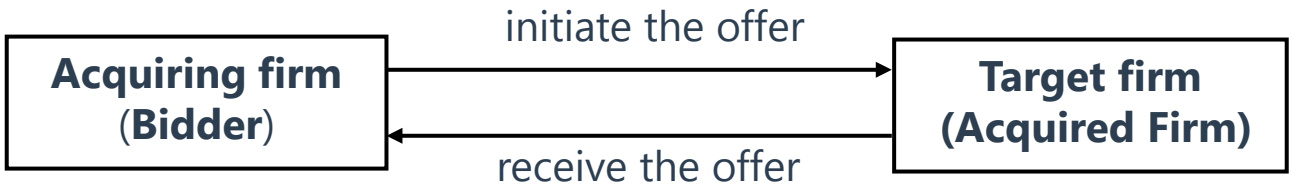
- **Directional Strategies: Trend Followers (Managed Futures) and Global Macro**
  - **① Managed Futures**
    - ✓ Managed futures funds typically focus on investing in listed bond, equity, commodity futures and currency markets, globally.
    - ✓ Managed futures fund managers tend to employ systematic trading programs that largely rely upon historical price data and market trends.
  - **② Global Macro**
    - ✓ Global macro funds typically focus on identifying mis-pricings in equity, currency, interest rate and commodity markets.
    - ✓ Managers typically employ a top-down global approach to analyze how political trends and global macroeconomic events may affect the valuation of financial instruments.

Hedge Fund Strategies

- **Event-Driven Strategies: Risk Arbitrage & Distressed**

① **Risk Arbitrage**

✓ As known as Merger Arbitrage.



✓ Attempt to capture the spreads in merger or acquisition transactions involving public companies after the terms of the transaction have been announced.

✓ For a stock deal, the bidder offers to exchange each target share for X shares of the bidder. In a fixed exchange ratio stock merger, one would go long the target stock and short the acquirer's stock according to the merger ratio, in order to isolate the spread and hedge out market risk.

✓ The principal risk is **usually deal risk**, should the deal fail to close.

Hedge Fund Strategies

- **Example - Merger Arbitrage**
  - On December 1, 1998, Exxon (Acquiring firm) confirmed that it had agreed to buy Mobil (Target firm), another major oil company. Under the terms of the agreement, each shareholder of Mobil would receive X = 1.32015 shares of Exxon in exchange. Before the announcement, the initial prices of Mobil and Exxon were $78.4 and $72.7, respectively.
  - Over the three days around the announcement, Mobil's stock price went up to $84.2 and Exxon's price went down to $71.6.
  - The exchange was consummated on November 30, 1999, after regulatory and shareholder approval. On that day, the respective stock prices for Mobil and Exxon were $104.4 and $79.3. Multiplying the latter by 1.32015, we get $104.7, which is close to the final stock price for Mobil. So**, the two prices converged to the same converted value.**
  - Profit from the risk arbitrage trade was

($104.4 - $84.2) – 1.32015*($79.3 - $71.6) = $10

Hedge Fund Strategies

② Distressed Securities

- ✓ Invest across the capital structure of companies subject to financial or operational distress or bankruptcy proceedings.
- ✓ Such securities often trade **at discounts** to intrinsic value due to difficulties in assessing their proper value, lack of research coverage, or an inability of traditional investors to continue holding them.
- ✓ The strategy may **focus on mispricing** caused by expected restructuring, reorganization, legal or regulatory issues, or corporate transactions.

Hedge Fund Strategies

- **Relative Value and Arbitrage-like Strategies:** Fixed Income Arbitrage, Convertible Arbitrage and Long/Short Equity

① **Fixed Income Arbitrage**

- ✓ Generate profits by exploiting inefficiencies and price anomalies between related fixed income securities.
- ✓ Strategies may include leveraging long and short positions in similar fixed income securities that are related either mathematically or economically.
- ✓ Seek to limit volatility by hedging out exposure to the market and interest-rate risk.

Hedge Fund Strategies

➢ **Example**

- Long-Term Capital Management (LTCM) started as a fixed-income arbitrage fund, taking positions in relative value trades, such as duration-matched positions in **long swap, short Treasuries**.
- On August 21, 1998, the 10-year Treasury yield dropped from 5.38% to 5.32%. The swap rate, increased from 6.01% to 6.05%.
- This divergence was highly unusual. Assuming a notional position of $50 billion and modified duration of eight years, this leads to
  - ✓ G/L of Short Treasury Position: $8 \times (5.32 - 5.38)/100 \times \$50{,}000 = -\$240 million$
  - ✓ G/L of Long Swap Position: $-8 \times (6.05 - 6.01)/100 \times \$50{,}000 = -\$160\ million$
- As the spread position is long the swap and short Treasury, this leads to a total loss of $400 million, close to 10% of capital.

Hedge Fund Strategies

② Convertible Arbitrage

- ✓ Managers typically build long positions of convertible and other equity hybrid securities and then hedge the equity component by shorting the underlying stock or options of that company.
- ✓ The number of stocks sold usually reflects a **delta neutral or market neutral ratio.** In other words, positions are typically designed with the objective of creating profit opportunities irrespective of market moves.
- ✓ **It is a net long gamma and vega strategy.**

③ Long/Short Equity

- ✓ Invest in both long and short sides of equity markets, often with a specific focus on certain sectors, regions or market capitalizations.
- ✓ Have flexibility of shifting from value to growth stocks, small cap to large cap stocks, and net short to net long position.

Hedge Fund Strategies

- **Niche Strategies: Dedicated Short Bias, Emerging Market and Equity Market Neutral**
  - **① Dedicated Short Bias**
    - ✓ Take more short positions than long positions and earn returns by maintaining net short exposure in long and short equities.
    - ✓ Detailed individual company research typically forms the core alpha generation driver of dedicated short bias managers, and a focus on companies with weak cash flow generation is common.
  - **② Emerging Market**
    - ✓ Invest in currencies, debt instruments, equities and other instruments of developing countries' markets.
  - **③ Equity Market Neutral**
    - ✓ Return behavior suggests that different funds apply different trading strategies with a similar goal of achieving almost zero beta(s) against a broad set of equity indices.

Hedge Fund Strategies

Funds of Hedge Funds

- A fund of hedge funds are portfolios of hedge funds, which add value by providing automatic diversification and careful selection of styles and investment managers.
- A major objective of the fund of hedge funds is optimal diversification.
- Funds of funds charge additional management fees on top of those levied by the underlying funds, typically around 1%.

Example

- A fund of hedge funds combines a mix of strategy sectors, managers, and styles, and therefore fund of funds risk managers need to understand the common attributes of hedge fund strategies. Which of the following statements is incorrect?
  - A. Equity market neutral funds aim to generate returns that have low correlation with the overall equity market and to insulate their portfolios from broad market risk factors.
  - B. Convertible arbitrage funds typically purchase securities that are convertible into the issuer's stock and simultaneously short the underlying stock. These funds earn returns in part form gamma trading on the stock's volatility.
  - C. Merger arbitrage funds buy the stock of an acquisition target company and simultaneously short the bidding company's stock. These funds have large exposure to deal risk.
  - D. Equity short-selling funds sell stocks not currently owned by the seller in order to take a directional bet that the stock price will decline. These funds tend to be uncorrelated with traditional long-only equity portfolios.
- **Correct Answer: D**

Example

- Identify the risks in a fixed-income arbitrage strategy that takes long positions in interest rate swaps hedged with short positions in Treasuries.
  A. The strategy could lose from decreases in the swap-Treasury spread.
  B. The strategy could lose from increases in the Treasury rate, all else fixed.
  C. The payoff in the strategy has negative skewness.
  D. The payoff in the strategy has positive skewness.
- **Correct Answer: C**

- Identify the risks in a convertible arbitrage strategy that takes long positions in convertible bonds hedged with short positions in Treasuries and the underlying stock.
  A. Short implied volatility
  B. Long duration
  C. Long stock delta
  D. Positive gamma
- **Correct Answer: D**

Risk Management of Hedge Fund

- **Risk Management Challenges**
  - Are heterogeneous
  - Hedge funds invest in illiquid assets
  - Most employ leverage
  - Some have high turnover
  - Exhibit a lack of transparency
  - Survivorship bias is a major consideration when hedge funds are evaluated as a group. This could significantly exaggerate their returns.

Risk Management of Hedge Fund

- **Hedge fund risks**
  - Liquidity risk
  - Leverage Risk
  - Agency Risk
  - Style Drift Risk
  - Fraud risk

Risk Management of Hedge Fund

- **Liquidity Risk**
  - On the asset side, liquidity risk is a function of the size of the positions, as well as of the price impact of a trade.
  - On the liabilities side, funding risk arises when the hedge fund cannot renew funding from its broker, or when losses in marked-to-market positions or increases in haircuts lead to cash outflows. Finally, funding risk also arises when the fund faces investor redemptions.

Risk Management of Hedge Fund

- Some funds invest in illiquid assets such as convertible bonds, which trade infrequently. In this case, risk measures based on monthly returns are misleading (the closing net asset value, NAV, does not reflect transaction prices)
- This create two biases:
  - ✓ Low correlations: correlations with other asset classes will be artificially lowered, giving the appearance of low systemic risk.
  - ✓ Low volatility: volatility will be artificially lowered, giving the appearance of low total risk. Such illiquidity, however, will show up in positive serial autocorrelation in returns.

Risk Management of Hedge Fund

- Using **Autocorrelation of Return** as a Measure of liquidity of the Asset.
  - ✓ The degree of serial autocorrelation in an asset's return is a proxy for the amount of illiquidity friction that is present.
  - ✓ More liquid assets should exhibit less serial autocorrelation than illiquid assets.
  - ✓ A **Q-statistic** is used as a summary measure of the overall statistical significance of autocorrelations.
    - ◆This statistical measure is approximately chi-squared distributed in large samples under the null hypothesis of no autocorrelations.
    - ◆Funds with large positive or negative autocorrelation coefficients will result in large Q-statistic.

Risk Management of Hedge Fund

Leverage Risk

- Leverage can create the problems, which can be classified as crowded trade risk.
- **Crowded trade risk** arises when many leveraged investors are on the same side of a trade. A loss in their portfolio may require them to post additional margin, which may be satisfied by several funds selling similar assets at the same time, which can create disruptions in markets.
- While wholesale liquidation of risky assets can occur globally for a variety of reasons inflicting stress on conventional long-biased strategies as well as hedge funds, it is the effect of leverage that makes hedge fund investment risk different from conventional long-bias strategies.
- Take LTCM and Bear Stearns for an example.

Risk Management of Hedge Fund

Agency Risk

- The principle-agent problem arises when the **incentive fee** to which hedge fund managers are entitled, typically at 15%-20% of new profits (or profits above a high water mark), entices a fund manager to take unreasonable bets.
- A manager may be tempted to take an unreasonable risk **so long as the option of closing shop and restarting in a new business if a large bet goes wrong is a feasible proposition**.

Risk Management of Hedge Fund

- Ways to reduce agency risk:
  - ✓ The incentive to take risk can be lessened with **high water marks** clause, which states that following a year in which the fund declined in value, the hedge fund would first have to recover those losses before any incentive fee would be paid.
  - ✓ The **cost** of fund closure being higher for large funds does partially mitigate this principal (investor) and agent (manager) conflict.
  - ✓ In addition, investors have a preference for funds in which the agents (fund managers) **invest a sizeable amount of their own wealth**.

Risk Management of Hedge Fund

➢ Style Drift

- Another potential problem is that of **style drift**, which refers to the fund manager' departure from his specialized skill area. Hedge fund style drift can occur in two ways:
  - ✓ Changes in the risk factor exposures of the fund, including changes in exposures to pre-existing risk factors or the emergence of exposures to new risk factors outside the scope of the manager's investment strategy.
  - ✓ Changes in the overall risk of the fund, primarily through changes in leverage.

Reasons for Style Drift
- Poor style market performance
- Excessive cash inflows
- Poor manager performance
- Recent losses
- Personnel change
- Regulatory change

Risk Management of Hedge Fund

- **Fraud risk**
  - **Unscrupulous hedge fund managers** have succumbed to the temptation to misreport the value of the fund's assets in order to hide their trading losses and even steal investors' assets. Improper valuation of assets arises when assets do not have market-clearing prices at the end of the reporting period and when fund managers calculate the NAV themselves.
  - **Ponzi scheme**: the scheme using new investor funds to repay earlier investors. The most famous case of a Ponzi scheme is the case of Bernard Madoff Investment Securities (BMIS). The possibility of fraud can be lessened when a fund has an independent administrator, an outside auditor and an external custodian.
  - **Due diligence** is the process of systematically investigating the fund before investing. This involves an analysis of the fund documents, of the key personnel, of the fund service providers, of the regulatory registration, and of the operations and valuation procedures.

Risk Management of Hedge Fund

Limitations of the VaR Measure

- VaR cannot capture the heterogeneous spectrum of risks among various hedge funds.
- VaR is a purely statistical measure of risk "with little or no economic structure underlying its computation"
- VaR is notoriously difficult to estimate. Tail events happen rarely: "generally too small a sample to yield reliable estimates of tail probabilities"
- VaR is an unconditional measure of risk: calculations are almost always based on the unconditional distribution of a portfolio's profit-and-loss. But for purposes of active risk management, conditional measures are more relevant.

Performance Evaluations for Hedge Fund

- **The difficulties in measuring the performance of hedge funds**
  - In practice, evaluating hedge funds poses considerable practical challenges. We can briefly mention a few of the difficulties:
    - ✓ The risk profile of hedge funds (both total volatility and exposure to relevant systematic factors) may change rapidly.
    - ✓ Hedge funds tend to invest in illiquid assets.
    - ✓ Many hedge funds pursue strategies that may provide apparent profits over long periods of time, but expose the fund to infrequent but severe losses.
    - ✓ Hedge funds have ample latitude to change their risk profiles and therefore considerable ability to manipulate conventional performance measures.
    - ✓ When hedge funds are evaluated as a group, survivorship bias can be a major consideration.

Example

- Risk management of hedge funds has challenges not generally faced in traditional investment management companies. Which of the following statements are correct about hedge fund risk management?

  I. Because hedge funds can hold long and short positions, and can use derivatives and leverage, their exposure to market risks can experience large and rapid changes that make it difficult to assess these exposures using only monthly returns.

  II. Many hedge funds use over-the counter derivatives, which are valued by models or quoted prices and often hold illiquid assets, as a result, the returns of these strategies generally exhibit much lower serial correlation than mutual fund returns.

  III. For hedge fund strategies that use leverage to amplify returns and rely on their ability to move out of trades quickly when they turn against them, liquidity risk must be closely monitored and managed.

  IV. Hedge fund returns are often similar to the return of a basket of exotic derivatives with nonlinear payoffs, and therefore assessing risk based on past performance can be misleading.

  A. I, II, III, and IV

  B. I, III, and IV

  C. I and III

  D. II and IV

- **Correct Answer: B**

Example

- You are asked to estimate the exposure of a hedge fund to the S&P 500. Though the fund claims to mark to market weekly, it does not do so and marks to market once a month. The fund also does not tell investors that it simply holds an Exchange Traded Fund (ETF) indexed to the S&P 500. Because of the claims of the hedge fund, you decide to estimate the market exposure by regressing weekly returns of the fund on the weekly return of the S&P 500. Which of the following correctly describes a property of your regression estimates?

  A. The intercept of your regression will be positive, showing that the fund has a positive alpha when estimated using an OLS regression.

  B. The beta will be misestimated because hedge fund exposures are nonlinear.

  C. The beta of your regression will be one because the fund holds the S&P 500.

  D. The beta of your regression will be zero because the fund returns are not synchronous with the S&P 500 returns.

- **Correct Answer: D**

Due Diligence

Definition

- Is the term used to describe the process of evaluation and analysis that an investor follows to **get comfortable** with a strategy, a manager, and a fund prior to making an investment.
- Investors would be wise to assess all three skill sets needed to run a modern-day hedge fund – investment, operational, and business skills – before committing capital to any fund.
- It includes all the steps that are needed to get to know:
  - ✓ Why and how a fund came into being.
  - ✓ The skills its founders or current partners claim to have mastered.
  - ✓ The evaluation of the timeliness, accuracy, and consistency of manager and fund information.
  - ✓ The reliability and independence of service providers;
  - ✓ And far more.

Due Diligence

- **Reasons for the Failures of Funds in the Past**
  - Funds can fail as a result of **bad investment decisions.**
  - Funds can also fail due to all sorts of **frauds,** including accounting frauds, valuation frauds, or misappropriation of funds.
  - Funds can fail due **to excessive leverage, improbable probabilities, unexpected events, and tail risk.**
  - Fund can get **caught in squeezes by other hedge funds.**
  - Funds can fail as a result of **a lack of supervision or compliance controls related to insider trading.**
  - Fund can fail due to **a flood of unanticipated withdrawals of capital at the least opportune time.** Funds can fail when liquidity dries up, and they can't meet redemptions.
  - Funds can fail because of their own actions or the acts of other.

Due Diligence

- **Conclusion:**
  - Investors need to evaluate each strategy and each manager with open eyes and take great care not to be blinded by the past success of any one person or strategy.
  - The more an investor assumes things can and will go wrong, the better the due diligence process and the more likely it is that an investor will uncover problems and/or ensure that attractive opportunities have a higher probability of success.

Due Diligence Process

- **The due diligence process**
  - Investment process
    - ✓ What is your strategy, and how does it work?
    - ✓ How is equity ownership allocated among the portfolio management, trading, and research Teams?
    - ✓ Is the track record reliable?
    - ✓ Who are the principals, and are they trustworthy?
  - Related risk controls.
    - ✓ How is risk measured and managed?
    - ✓ How are securities valued?
    - ✓ What is the portfolio leverage and liquidity?
    - ✓ Does the strategy expose the investor to tail risk?
    - ✓ How often do investors get risk reports, and what do they include?
    - ✓ Do the fund terms make sense for the strategy?

Due Diligence Process

- **The due diligence process**
  - Operational Environment
    - ✓ Internal Control Assessment
    - ✓ Documents and Disclosures
    - ✓ Service Provider Evaluation
  - Model Risk and Fraud Risk
    - ✓ Due diligence process **of business model risk** deals with the risks encompassed in **simply running the business of being a hedge fund.**
    - ✓ Investors in hedge funds always need to be on the lookout for fraud. Despite the due diligence done on the investment, risk management, and operational practices of a manager or fund, and even where there is a complete understanding of the business model risk, investors can still find themselves defrauded.

Example

- In performing due diligence on a potential investment manager, which of the following factors is the least important for the investor to consider?
  - A. Risk controls.
  - B. Business model.
  - C. Past performance.
  - D. Investment process.

- **Correct Answer: C**

It's not the end but just beginning.

If you have people you love, allow them to be free beings. Give and don't expect. Advise, but don't order. Ask, but never demand. It might sound simple, but it is a lesson that may take a lifetime to truly practice. It is the secret to true Love. To truly practice it, you must sincerely feel no expectations from those who you love, and yet an unconditional caring.

如果你有爱的人，允许他们自由随意的存在。给予而不指望；建议而不命令；请求而不要求；可能听起来简单，但这需要一辈子去实践。这就是真爱的秘诀。真正去实践它，你必须对那些你爱的人没有期望，并给予无条件的关爱。

问题反馈

- 如果您认为金程**课程讲义/题库/视频**或其他资料中**存在错误，欢迎您告诉我们**，所有提交的内容我们会在最快时间内核查并给与答复。
- **如何告诉我们？**
  - 将您发现的问题通过电子邮件告知我们，具体的内容包含：
    - ✓ 您的姓名或网校账号
    - ✓ 所在班级（eg.1911FRM一级长线无忧班）
    - ✓ 问题所在科目（若未知科目，请提供章节、知识点）和页码
    - ✓ 您对问题的详细描述和您的见解
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