Portfolio Management

CFA二级培训项目

讲师：王慧琳

101% Contribution Breeds Professionalism

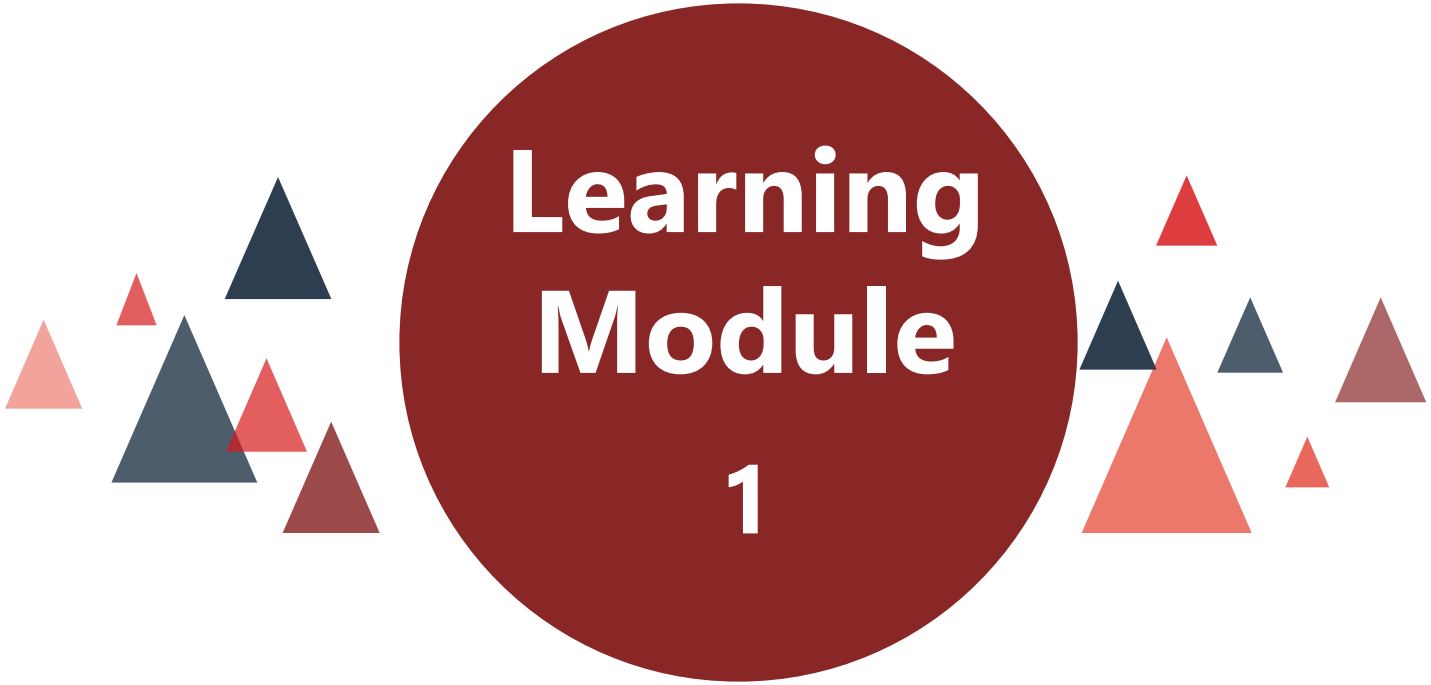
Topic Weightings in CFA Level II

Content	Weightings
Quantitative Methods	5-10
Economics	5-10
Financial Statement Analysis	10-15
Corporate Issuers	5-10
Equity	10-15
Fixed Income	10-15
Derivatives	5-10
Alternative Investments	5-10
Portfolio Management	**10-15**
Ethical and Professional Standards	10-15

Framework

Portfolio Management

- **Portfolio Management (1)**
  - LM1 Exchange-Traded Funds: Mechanics and Applications
  - LM2 Using Multifactor Models
  - LM3 Measuring and Managing Market Risk
  - LM4 Backtesting and Simulation
- **Portfolio Management (2)**
  - LM1 Economics and Investment markets
  - LM2 Analysis of Active Portfolio Management



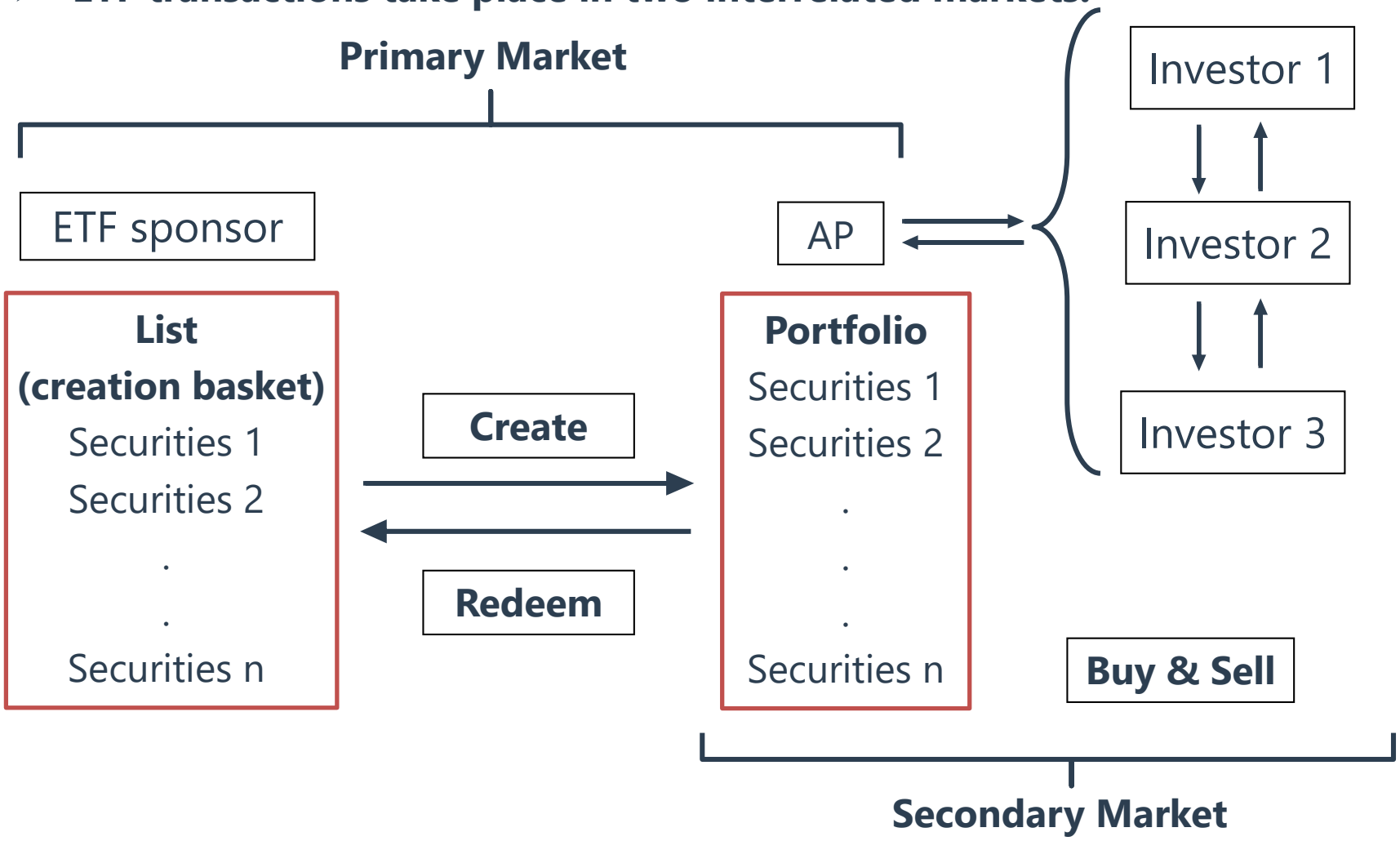
Exchange-Traded Funds: Mechanics and Applications

Framework

1. ETF Mechanics
   - Creation/redemption process
   - Arbitrage
   - Advantages of the ETF mechanics
   - Trading and settlement
2. Understanding ETF
   - Expense ratio
   - Tracking Error
   - Trading costs
   - Tax issues
   - Total Costs of ETF Ownership
   - Types of ETF risks
3. ETFs in Portfolio Management

1. ETF Mechanics

- **ETF transactions take place in two interrelated markets.**



The Creation/Redemption Process

- The **primary market** for ETF trading is that which exists on an **over-the-counter** basis between **authorized participants (APs),** and the **ETF issuer, or sponsor.**
  - The **only** investors who can create or redeem new shares of an ETF are a special group of **institutional investors** called **APs**.
    - ✓ APs are large broker/dealers, often market makers, who are authorized by the ETF issuer to participate in the process.
  - The AP creates new ETF shares by transacting ***in-kind*** with the ETF issuer. This in-kind swap happens off the exchange, in the primary market for the ETF, where APs transfer securities to (**for creations**) or receive securities from (**for redemptions**) the ETF issuer, in exchange for ETF shares.

1.2 Motivations for APs to Trade

- **Arbitrage keeps the ETF trading at or near its fair value.**
  - If shares of the ETF are quoted at a **higher** price than the per-share market value of the basket of securities, the ETF is ***trading at a premium***, and the AP can make a profit by simultaneously selling the ETF shares and buying the basket of securities. **(ETF Price > NAV)**
    - ✓ The AP may choose to ***create additional ETF shares*** by exchanging the basket securities for ETF shares with the fund's issuer.
  - If the current per-share market value of the basket of underlying securities is greater than the quoted price of the ETF shares, the AP can simultaneously sell (or short) the basket of securities and buy ETF shares, to make a profit. In this situation, where the ETF share is undervalued, the ETF is said to be ***trading at a discount***. **(ETF Price < NAV)**
    - ✓ The AP may choose to ***redeem ETF shares*** by exchanging them for the basket securities with the fund's issuer.

Motivations for APs to trade

- Because prices of the ETF and the basket securities are **continuously changing** on the basis of market conditions, APs monitor both for discrepancies, looking for opportunities to make arbitrage profits.
  - The **arbitrage gap** —the price(s) at which it makes sense for ETF market makers to step in and create or redeem shares—vary with the liquidity of the underlying securities and a variety of related costs.
    - ✓ Because the **liquidity** of the **securities in the basket** determines the transaction cost, the arbitrage gap tends to be **wider** for ETF with illiquid holdings.
    - ✓ **Timing difference** increases risk for the AP, leading to a **wider** arbitrage gap.
    - ✓ Creation/redemption fee

2. Understanding ETFs

- To best understand an ETF's ability to meet expectations, one should consider its:
  - Expense ratio
  - Tracking error
  - Trading costs
  - Tax issues
  - Total costs of ETF ownership

2.1 Expense Ratios

- ETFs generally charge ***lower fees*** than mutual funds
  - ETF providers do not have to keep track of individual investor accounts, since ETF shares are held by and transacted through brokerage firms. Nor do ETF issuers bear the costs of communicating directly with individual investors.
  - Index-based portfolio management, used by most ETFs, **does not require the security and macroeconomic research carried out by active managers**, which increases fund operating costs.

2.2 Tracking Error

- ETF managers attempt to deliver performance that tracks the fund's benchmark as ***closely*** as possible (after subtracting fees). This can be measured by comparing ETF performance with index returns.
  - **Daily differences:** Index tracking is often evaluated using the one-day difference in returns between the fund, as measured by its NAV, and its index.
  - **Periodic tracking:**
    - ✓ **Tracking error** is defined as the ***standard deviation*** of differences in daily performance between the index and the fund tracking the index.
      - ◆ Not reveal the extent to which the fund is under or over performing
    - ✓ An alternative approach is to look at tracking differences calculated over a longer holding period. A series of **rolling holding periods** can be used to represent both central tendencies and variability. This approach allows investors to see the cumulative effect of portfolio management and expenses over an extended period. (best assess an ETF's performance)

Tracking Error

- **Sources of tracking error include the following:**
  - **(1) Fees and expenses** - Index calculation generally assumes that trading is frictionless and occurs at the closing price. A fund's operating fees and expenses reduce the fund's return relative to the index.
  - **(2) Representative sampling/optimization** - Rather than fully replicate the index, funds may hold only a subset of index securities to track the benchmark index.
  - **(3) Index changes** - Funds may trade index changes at times and prices that are different from those of the benchmark tracked.
    - ✓ Since rebalance is infrequent, this part is often the ***smallest contributor***.
    - ✓ ETF portfolio managers can use the creation/redemption process to manage rebalance trades, by cooperating with APs to ensure market-on-close pricing on the rebalance date, thus minimizing this source of tracking error.

Tracking Error

- **Sources of tracking error include the following: (Con't)**
  - **(4) Depositary receipts and other ETFs** - Funds may hold securities that are different from those in the index.
  - **(5) Fund accounting practices** - Fund accounting practices may differ from the index calculation methodology—for example, valuation practices for foreign exchange and fixed income.
    - ✓ Differences in valuation practices between the fund and its index can create discrepancies that magnify daily tracking differences.
  - **(6) Regulatory and tax requirements** - Funds may be subject to regulatory and tax requirements that are different from those assumed in index methodology
  - **(7) Asset manager operations** - ETF issuers may attempt to offset costs through security lending and foreign dividend recapture. These act as "negative" costs, which enhance fund performance relative to the index.

2.3 Trading Costs

- **ETF costs**
  - Management fees; - long term investor
  - Trading costs (market impact):
    - ✓ Commission;
    - ✓ **bid–ask spread of the ETF;**
    - ✓ **ETF premium and discount**.

Short term, tactical investor

- **Holding period cost**

$$\begin{aligned} &\boldsymbol{Holding\ period\ cost}\ (\%) \\ &= \boldsymbol{two\ way\ commission}\ (\%) + \boldsymbol{bid - ask\ spread}(\%) \\ &+ \boldsymbol{Management\ fee\ for\ period}\ (\%) \end{aligned}$$

ETF Bid-Ask Spreads

- **The primary factors that determine the width of the quoted bid–ask spread for a particular transaction size are:**
  - the amount of ongoing order flow in the ETF, as measured by daily share volume (***more flow means lower spreads***);
  - the amount of competition among market makers for that ETF (***more competition means lower spreads***);
  - the actual costs and risks for the liquidity provider. (***less costs and risks means lower spreads***).

ETF Bid–Ask Spreads

- ETF bid–ask spreads are generally less than or equal to the **combination of the following:**
  - ± Creation/redemption fees and other direct trading costs, such as brokerage and exchange fees
    - ✓ The bid–ask spread for **very liquid, high-volume ETFs** will be ***least influenced*** by the creation/redemption fees and other direct costs.
  - + ***Bid–ask spreads of the underlying securities held in the ETF***
    - ✓ ***Most important driver***
  - + Compensation (to market maker or liquidity provider) for the risk of hedging or carrying positions for the remainder of trading day
  - + Market maker's desired profit spread, subject to competitive forces
  - – Discount related to the likelihood of receiving an offsetting ETF order in a short time frame

Premiums and Discounts

- **ETF premiums and discounts are driven by a number of factors, including timing differences and stale pricing.**
  - **(1) Timing differences**
    - ✓ NAV is often a poor fair value indicator for ETFs that ***hold foreign securities*** because of ***differences in exchange closing times*** between the underlying (e.g., foreign stocks, bonds, or commodities) and the exchange where the ETF trades.
  - **(2) Stale pricing**
    - ✓ ETFs that ***trade infrequently*** may also have large premiums or discounts to NAV. If the ETF has not traded in the hours leading up to the market close, NAV may have significantly risen or fallen during that time owing to market movement.

2.4 Tax of Capital Gains Distributions

- In general, funds must distribute any capital gains realized during the year. On average, **ETFs distribute *less* in capital gains than competing mutual funds** for two primary reasons.
  - **(1) Tax fairness**
    - ✓ In a **traditional mutual fund**, shareholders may have to pay tax liabilities triggered by other shareholders redeeming out of the fund.
    - ✓ For **ETF**, the **selling activities** of individual investors in the secondary market do not require the fund to trade out of its underlying positions.
    - ✓ If an **AP redeems ETF shares**, this redemption occurs in kind and is not a taxable event. Thus, redemptions do not trigger capital gain realizations.
    - ✓ This aspect is why ETFs are considered "**tax fair**": ***The actions of investors selling shares of the fund do not influence the tax liabilities for remaining fund shareholders*.**

Tax of Capital Gains Distributions

- On average, **ETFs distribute less in capital gains than competing mutual funds** for two primary reasons. (Con't)
  - **(2) Tax efficiency**
    - ✓ When an authorized participant submits shares of an ETF for **redemption**, the ETF manager can choose shares with the ***largest unrealized capital gains***—that is, those acquired at the lowest cost basis—ETF managers can use the in-kind redemption process to ***reduce potential capital gains*** in the fund.

2.5 Total Costs of ETF Ownership

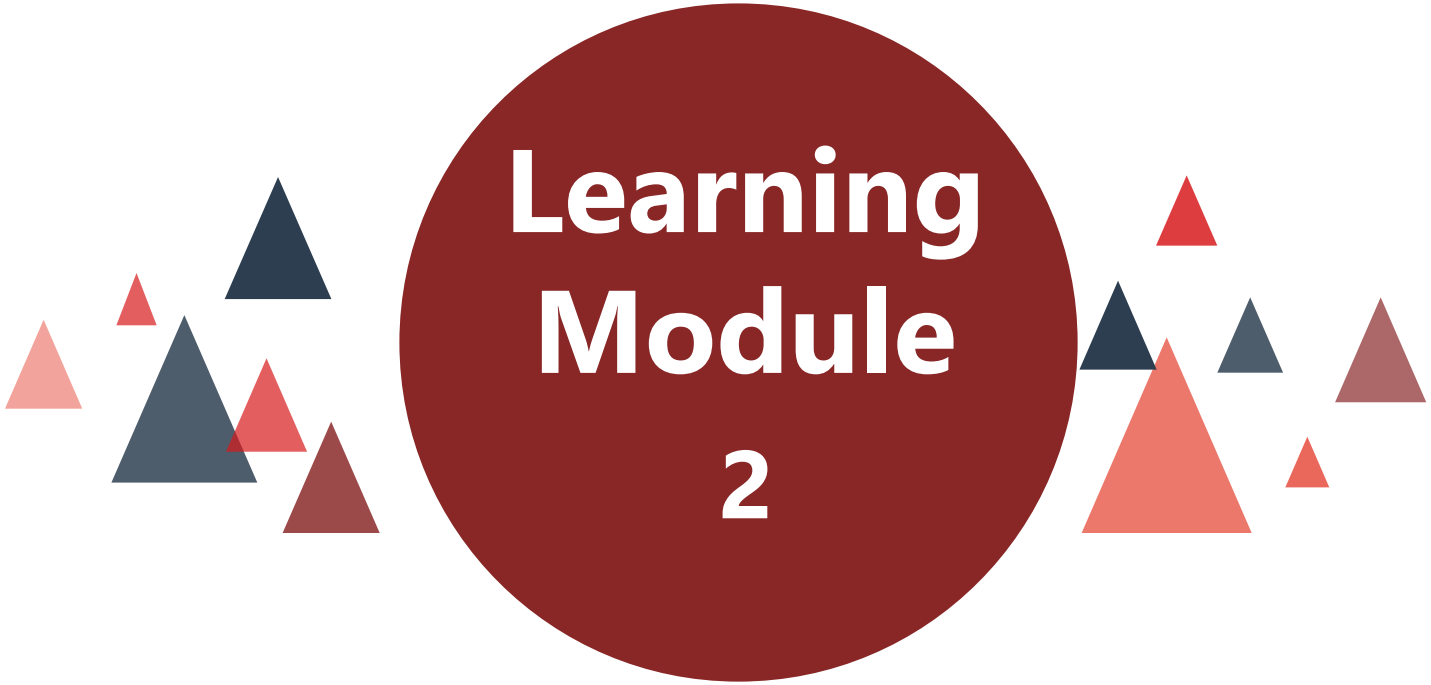
Fund Cost Factor	Function of Holding Period?	Explicit/ Implicit	ETFs	Mutual Funds
Management fee	Y	E	√ (often less)	√
Tracking error	Y	I	√ (often less than comparable index mutual funds)	(index funds only)
Commissions	N	E	√ (some free)	×
Bid–ask spread	N	I	√	×
Premium/discount to NAV	N	I	√	×
Portfolio turnover (from investor flows and fund management)	Y	I	√ (often less)	√
Taxable gains/losses to investors	Y	E	√ (often less)	√
Security lending	Y	I	√ (often more)	√

2.6 Types of ETF risks

Types of ETF risks	
➢ **Counterparty Risk:** A counterparty failure can put the investor's principal at risk of default or affect a portion of the assets via settlement. Counterparty activity can affect a fund's economic exposure. (ETN)	➢ Security lending ➢ Settlement risk
➢ **Fund Closures:** Primary reasons for a fund to close include regulation, competition, and corporate activity. "Soft" closures—which do not involve an actual fund closing—include creation halts and changes in investment strategy.	➢ Regulations ➢ Competition ➢ Corporate actions ➢ Creation halts ➢ Change in investment strategy
➢ **Investor-Related Risk:** ETFs may introduce risks to investors who do not fully understand them. For many investors, leveraged and inverse ETFs fall into this category by failing to meet investor expectations.	

3. ETFs in Portfolio Management

➢ **Portfolio efficiency:** The use of ETFs to better manage a portfolio for efficiency or operational purposes.	• Cash Equalization / Liquidity Management • Portfolio Rebalancing • Portfolio Completion • Manager Transition Activity
➢ **Asset class exposure management:** The use of ETFs to achieve or maintain core exposure to key asset classes, market segments, or investment themes on a strategic, tactical, or dynamic basis.	• Core exposure to an asset class or sub-asset class • Tactical strategies
➢ **Active and factor investing:** The use of ETFs to target specific active or factor exposures on the basis of an investment view or risk management need.	• Factor ETFs • Risk management • Alternative weighting • Discretionary active ETFs • Dynamic asset allocation and multi-asset strategies



Using Multifactor Models

Using Multifactor Models

- Arbitrage Pricing Theory (APT)
- Multifactor models
  - ✓ Macroeconomic factor model
  - ✓ Fundamental factor model
- Application
  - ✓ Return attribution
  - ✓ Risk attribution
  - ✓ Portfolio construction

1. Arbitrage Pricing Theory (APT)

- **Exactly formula**

$$E(R_P) = R_F + \lambda_1\beta_{P,1} + \lambda_2\beta_{P,2} + \cdots + \lambda_k\beta_{P,k}$$

  - λ_j = the expected reward for bearing the risk of factor j (factor risk premium)
  - β_j = the sensitivity of the portfolio to factor j

- **APT** provides an expression for the expected return of asset i assuming that financial markets are in **equilibrium**.

- **Assumptions:**
  - A factor model describes asset returns
  - There are many assets, so investors can form well-diversified portfolios that eliminate asset-specific risk
  - No arbitrage opportunities exist among well-diversified portfolios

Arbitrage Pricing Theory (APT)

- **参数 Characteristics**
  - 不同的asset，λ_i一样，$\beta_{P,i}$不一样
  - Factor risk premium (or factor price, λj) is also called a **pure factor portfolio** for factor j.
    - ✓ Sensitivity equal to 1 to only one risk factor
    - ✓ Sensitivities of 0 to the remaining factors

Example

- Suppose that two factors, surprise in inflation (factor 1) and surprise in GDP growth (factor 2), explain returns. According to the APT, an arbitrage opportunity exists unless

$$E(R_p) = R_F + \beta_{p,1}(\lambda_1) + \beta_{p,2}(\lambda_2)$$

- Well-diversified portfolios, J, K, and L, given in table.

Portfolio	Expected return	Sensitivity to inflation factor	Sensitivity to GDP factor
J	0.14	1.0	1.5
K	0.12	0.5	1.0
L	0.11	1.3	1.1

$$\left.\begin{aligned} E(R_J) &= 0.14 = R_F + 1.0\lambda_1 + 1.5\lambda_2 \\ E(R_K) &= 0.12 = R_F + 0.5\lambda_1 + 1.0\lambda_2 \\ E(R_L) &= 0.11 = R_F + 1.3\lambda_1 + 1.1\lambda_2 \end{aligned}\right\} E(R_p) = 0.07 - 0.02\beta_{p,1} + 0.06\beta_{p,2}$$

Carhart Four-factor Model

- **Equilibrium expected return:**
  - $E(R_P) = RF + \beta_{P,1}RMRF + \beta_{P,2}SMB + \beta_{P,3}HML + \beta_{P,4}WML$
  - **RMRF** = the return on a ***value-weighted equity index*** in excess of the **one-month T-bill rate**
  - **SMB = small minus big**, a size (***market capitalization***) factor; SMB is the average return on three small-cap portfolios minus the average return on three large-cap portfolios
  - **HML = high minus low**, the average return on two high ***book-to-market*** portfolios minus the average return on two low book-to-market portfolios
  - **WML = winners minus losers**, a ***momentum factor***; WML is the return on a portfolio of the past year's winners minus the return on a portfolio of the past year's losers

2. Types of Multifactor Models

- **Macroeconomic factor model:** the factors are surprise in ***macroeconomic variable*** that significantly explain returns.
  - For example: interest rates, inflation risk, business cycle risk, and credit spreads
- **Fundamental factor model:** the factors are attributes of ***stocks or companies*** that are important in explaining cross-sectional differences in stock prices.
  - For example: book-value-to-price ratio, market capitalization, the price-to-earnings ratio, and financial leverage.

Macroeconomic Factor Model (参数、公式)

Macroeconomic Factor

- Surprise = actual value – predicted (expected) value
- Exact formula for return of asset i

$$R_i = E(R_i) + b_{i1}F_{GDP} + b_{i2}F_{QS} + \varepsilon_i$$

回归出b_{i1}, b_{i2}

Regression **(time series)**		
Return	F_{GDP}	F_{QS}
…	…	…
…	…	…
…	…	…
…	…	…
…	…	…

Where: R_i = return for asset i

$E(R_i)$ = expected return for asset i

F_{GDP} = surprise in the GDP rate

F_{QS} = surprise in the credit quality spread

b_{i1} = GDP surprise sensitivity of asset i

b_{i2} = credit quality spread surprise sensitivity of asset i

ε_i = firm-specific surprise which not be explained by the model.

Fundamental Factor

$$R_i = a_i + b_{i1}F_{\mathrm{P/E}} + b_{i2}F_{SIZE} + \varepsilon_i$$

- 不同公司的R和对应的b_{i1}，b_{i2}

回归出$F_{P/E}$，F_{size}

No economic interpretation

$$b_{ij} = \frac{\text{Asset}_{\text{i}}\text{'s attribut value} - \text{average attribute value}}{\sigma(\text{attribute value})}$$

$$e.g.\, b_{i1} = \frac{(\mathrm{P/E})_1 - \overline{\mathrm{P/E}}}{\sigma_{P/E}}$$

Regression **(cross sectional data)**		
Return	b_{i1}	b_{i2}
…	…	…
…	…	…
…	…	…
…	…	…
…	…	…

Standardized beta: the scaling permits all factor sensitivities to be interpreted similarly, ***despite differences in units of measure and scale*** in the variables.

Statistical Factor Models

- **Statistical factor models**
  - Statistical methods are applied to historical returns of a group of securities to extract factors that can explain the observed returns of securities in the group.
  - The factors are actually portfolios of the securities in the group under study and are therefore defined by portfolio weights.
  - Two major types of factor models are factor analysis models and principal components models.
    - ✓ **Factor analysis models** best explain historical return covariances.
    - ✓ **Principal components models** best explain the historical return variances.
  - Advantage and Disadvantage
    - ✓ Major advantage: it make minimal assumptions, can be most easily applied to various asset classes, including fixed income.
    - ✓ Major weakness: the interpretation of statistical factors is generally difficult in contrast to macroeconomic and fundamental factors

Fixed-Income Multifactor Models

Macroeconomic Multifactor Models

- Consider a bond factor model with two factors.
- $R_i = \alpha_i + b_{i1}F_{INFL} + b_{i2}F_{GDP} + \varepsilon_i$
  - ✓ R_i=the return to bond i
  - ✓ α_i=the expected return to bond i
  - ✓ b_{i1}=the sensitivity of the return on bond i to inflation rate surprises
  - ✓ F_{INFL}=the surprise in inflation rates
  - ✓ b_{i2}=the sensitivity of the return on bond i to GDP growth surprises
  - ✓ F_{GDP}=the surprises in GDP growth
  - ✓ ε_i=an error term with a zero mean that represents the portion of the return to bond i not explained by the factor model.

Fixed-Income Multifactor Models

➢ Fundamental Multifactor Models

- The simplistic approach:

$$R_i = a_i + b_{i1}F_{Gvt\_Sh} + b_{i2}F_{Gvt\_Int} + b_{i3}F_{Gvt\_Lg} + b_{i4}F_{Invest} + b_{i5}F_{HiYld} + b_{i6}F_{MBS} + \varepsilon_i$$

  - ✓ R_i=the return to bond i
  - ✓ a_i=the expected return to bond i
  - ✓ b_{ik}=the sensitivity of the return on bond i to factor k
  - ✓ F_k=factor k, where k represents "Gov't (Short)," "Gov't (Long)," and so on
  - ✓ ε_i=an error term with a zero mean that represents the portion of the return to bond i not explained by the factor model

- The historic style factor weights, b_{ik} , are determined by a constrained regression (the total "weights" add up to 100%) of the portfolio returns against the listed style factors.
- This framework lends itself readily to performance and risk attribution, along with portfolio construction, it can also be extended to ESG considerations.

Fixed-Income Multifactor Models

➢ Risk and Style Multifactor Models

- Another category of multifactor approach incorporates risk, or style, factors , factors, several of which can thematically apply across asset classes.
  - ✓ Examples: momentum, value, carry, and volatility
- Statistical models can be most easily applied to various asset classes, including fixed income, as no asset-class- specific tuning is required given the minimal required assumption set.
- Macroeconomic and fundamental models both require adjustments and repurposing to ensure the frameworks are fit for the specifics of bond investing.

3. Application: Return Attribution

- **Active return =Return from factor tilts + Return from security selection**
  - **Return from factor tilts: (Asset Allocation)**
    - ✓ overweight or underweight relative to the benchmark factor sensitivities

$$= \sum_{k=1}^{K} [(\text{Portfolio sensitivity})_k - (\text{Benchmark sensitivity})_k] \times (\text{Factor return})_k$$

  - **Return form security selection: (Security selection)**
    - ✓ ability to overweight securities that outperform the benchmark or underweight securities that underperform the benchmark.

Application: Risk Attribution

- **Active risk**
  - Definition: the standard deviation of active returns
  - Exactly formula:

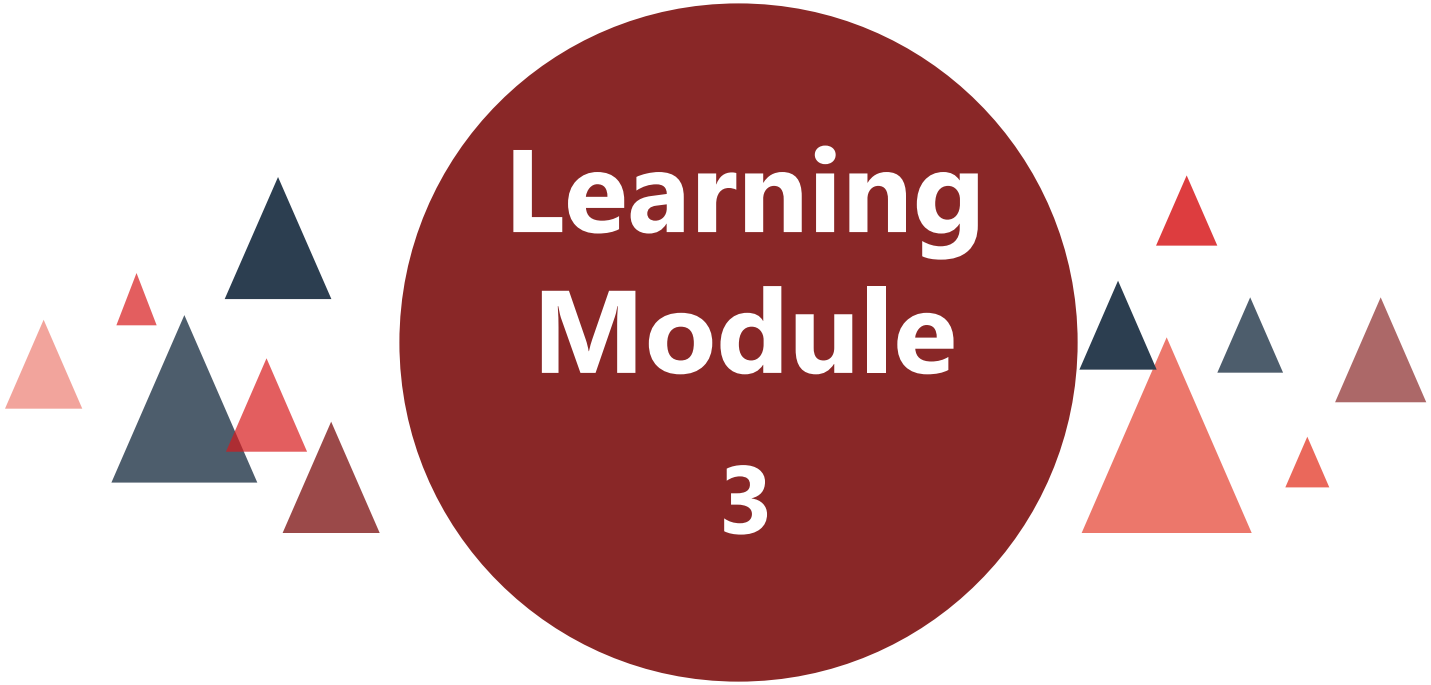
$$Active\ risk = s_{(R_P - R_B)} = \sqrt{\frac{\sum (R_{Pt} - R_{Bt})^2}{t-1}}$$

$$Active\ risk\ squared = s^2(R_P - R_B)$$

  - **Active risk squared = Active factor risk + Active specific risk**
  - **Active factor risk:** the portfolio's different-than-benchmark exposures relative to factors specified in the risk model
  - **Active specific risk** (security selection risk): the portfolio's active weights on individual assets as those weights interact with assets' residual risk.

Application: Portfolio Construction

- **Passive management.** Analysts can use multifactor models to match an index fund's factor exposures to the factor exposures of the index tracked.
- **Active management.** Many quantitative investment managers rely on multifactor models in predicting alpha (excess risk-adjusted returns) or relative return (the return on one asset or asset class relative to that of another) as part of a variety of active investment strategies**.**
  - In evaluating portfolios, analysts use multi-factor models to understand the sources of active managers' returns and assess the risks assumed relative to the manager's **benchmark** (comparison portfolio).
- **Rules-based active management (alternative indexes).** These strategies routinely tilt toward factors such as size, value, quality, or momentum when constructing portfolios.



Measuring and managing market risk

Measuring and Managing Market risk

- Understanding VaR
- Estimate VaR (描述、缺点)
  - ✓ Analytical (variance-covariance) method
  - ✓ Historical method
  - ✓ Monte Carlo simulation method
- Extensions of VaR
- Other key risk measures: sensitivity measure and scenario analysis
  - ✓ Advantage
  - ✓ Limitation

1. Understanding VaR

- **VaR** states at some **significance level** (often 1 % or 5%) the **minimum loss during a specified time period**. The loss can be stated as **a percentage of value or as a nominal amount**. VaR always has a **dual interpretation**.
  - The VaR time period should relate to the nature of the situation.
    - ✓ A traditional stock and bond portfolio would likely focus on a longer monthly or quarterly VaR
    - ✓ highly leveraged derivatives portfolio might focus on a shorter daily VaR.
  - The percentage selected will affect the VaR. A 1% VaR would be expected to show greater risk than a 5% VaR.
  - The **left-tail** should be examined.

2. Estimating VaR

- 3 methods to estimate VaR:
  - **Parametric method** (variance-covariance/Analytical method)
  - **Historical method**
  - **Monte Carlo method**

Parametric Method

- **The parametric method** typically assumes that the return distribution for the risk factors in the portfolio are ***normal***. It then uses the expected return and standard deviation of return for each risk factor to estimate the VaR.
- $\boldsymbol{VaR = |R_P - z \times \sigma| \times V_P}$
- The major advantage of the parametric method is its simplicity and straightforwardness. One of the major weakness is that it can be difficult to use when the portfolio contains options.
  - Advantages of the analytical method include:
    - ✓ Easy to calculate and easily understood as a single number.
    - ✓ Allows modeling the correlations of risks.
    - ✓ Can be applied to shorter or longer time periods as relevant.
  - Disadvantages of the analytical method include:
    - ✓ Assumes normal distribution of returns
      - ◆ Some securities have skewed returns.
      - ◆ Many assets exhibit leptokurtosis (fat tails).
    - ✓ The difficulty of estimating standard deviation in very large portfolios.

For the Exam

- **5% VaR is 1.65** standard deviations below the mean.
- **1% VaR is 2.33** standard deviations below the mean.
- VaR for periods less than a year are computed with return and standard deviations expressed for the desired period of time.
  - For **monthly VaR**, divide the annual return by 12 and the standard deviation by the square root of 12. Then, compute monthly VaR.
  - For **weekly VaR**, divide the annual return by 52 and the standard deviation by the square root of 52. Then, compute weekly VaR.
- **For a very short period (1-day) VaR** can be approximated by ignoring the return component (i.e., enter the return as zero). This will make the VaR estimate worse as no return is considered, but over one day the expected return should be small.

Historical Method

- **Use the historical data to find out Value at risk.**
- You have accumulated 100 daily returns for your $100,000,000 portfolio. After ranking the returns from highest to lowest, you identify the lower five returns:

  -0.0019, -0.0025, -0.0034, -0.0096, -0.0101

  Calculate daily VaR at 5% significant using the historical method.
- **Answer:**

  Since these are the lowest five returns, they represent the 5% lower tail of the “distribution” of 100 historical returns. The fifth lowest return (-0.0019) is the 5% daily VaR. We should ay there is a 5% chance of a daily loss exceeding 0.19%, or $190,000.

Historical Method

- **Advantages** of the historical method include:
  - Very easy to calculate and understand.
  - Does not assume a returns distribution. (离散的VaR)
  - Estimates VaR based on what actually happened
- **The primary disadvantage** of the historical method is the assumption that the pattern of historical returns will repeat in the future (i.e., it is indicative of future returns).

Monte Carlo Simulation Method

- **The primary advantage of the Monte Carlo method is also its primary disadvantage.**
  - It can incorporate **any assumptions**
  - That leads to its **Downside**:
    - ✓ the output is only as good as the input assumptions.
    - ✓ **Complexity** can lead to a false sense of overconfidence in the output among the less informed.
    - ✓ It is data and **computer intensive** which can make it **costly** to use in complex situations (where it may also be the only reasonable method to use).

3. Extensions of VaR

- **Conditional VaR (CVaR):**the **average loss** that would be incurred if the VaR cutoff is exceeded. CVaR is also sometimes referred to as the expected tail loss or expected shortfall.
- **Incremental VaR (IVaR):** how the portfolio VaR will change if a position size is changed relative to the remaining positions.
- **Marginal VaR (MVaR):** it is conceptually similar to incremental VaR in that it reflects the effect of an anticipated change in the portfolio, but it uses formulas derived from calculus to reflect the effect of a very small change in the position.
- **Ex ante tracking error**, also known as relative VaR : a measure of the degree to which the performance of a given investment portfolio might deviate from its benchmark.

4. Other Key Risk Measures

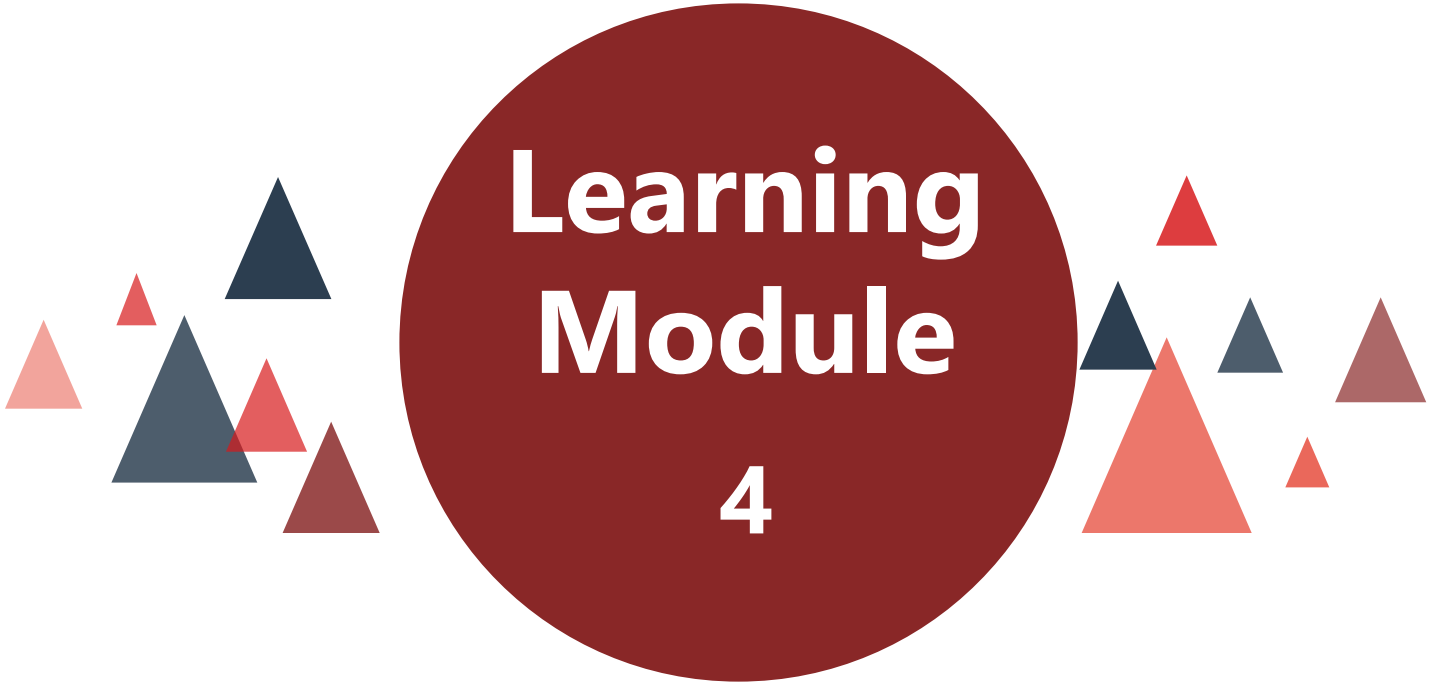
- **Sensitivity**
  - Sensitivity measures examine how performance responds to a ***single change*** in an underlying risk factor.
    - ✓ Equity Exposure Measures: Beta from (CAPM)
    - ✓ Fixed-income Exposure Measure: Duration, convexity
    - ✓ Options Risk Measures: Delta, gamma, Vega
  - **Limitations**
    - ✓ Do not often distinguish assets by volatility, which makes it less comparable.
- **Scenario Risk Measures**
  - **Historical scenarios** are scenarios that measure the hypothetical portfolio return that would result from a repeat of a particular period of financial market history.
  - **Hypothetical scenarios**—extreme movements and co-movements in different markets that have not necessarily previously occurred.

Advantages and Limitations of Other Measures

- **Scenario Risk Measures**
  - Advantage
    - ✓ do not need to rely on history;
    - ✓ overcome any assumption of normal distributions;
    - ✓ allowing liquidity to be taken into account.
  - Limitations
    - ✓ Historical scenarios are not going to happen in exactly the same way again;
    - ✓ Hypothetical scenarios may incorrectly specify how assets will co-move,
    - ✓ Hypothetical scenarios can be very difficult to create and maintain,

Scenario Risk Measures

- **Scenario analysis and stress tests**
  - **Stress tests**, which apply ***extreme negative stress*** to a particular portfolio exposure, are closely related to scenario risk measures.
  - To design an effective hypothetical scenario, it's necessary to identify the portfolio's most significant exposures. Targeting these material exposures and assessing their behavior in various environments is called **reverse stress testing.**
  - **Scenario analysis** is an ***open-ended exercise*** that could look ***at positive or negative events.***



Backtesting and Simulation

Framework

1. Objectives of backtesting
2. Backtesting process
3. Problems in backtesting
4. Historical scenario analysis
5. Simulation
6. Sensitivity analysis

1. Objectives of Backtesting

- **Backtesting** approximates the real-life investment process by using historical data to assess whether a strategy would have produced desirable results.
- Backtesting can offer investors insight and rigor to the investment process.
- Backtesting can be employed as a rejection or acceptance criterion for an investment strategy.
- Backtesting fits quantitiative and systematic investment styles, it is also widely used by fundamental managers.
- Before using a criterion to screen for stocks, a backtest can uncover the historical efficacy of that criterion by determining if its use would have added incremental excess return.

2. Backtesting Process

- **Steps and procedures**
  - **Step 1: Strategy design**
    - ✓ Specify investment hypothesis and goals
    - ✓ Determine investment rules and process
    - ✓ Decide key parameters
  - **Step 2: Historical investment simulation**
    - ✓ Form investment portfolios for each period according to the rules specified in the previous step
    - ✓ Rebalance the portfolio periodically based on pre-determined rules
  - **Step 3: Analysis of backtesting output**
    - ✓ Calculate portfolio performance statistics
    - ✓ Compute other key metrics

Backtesting Process

- **Key parameters**
  - **Investment universe**
    - ✓ It refers to all of the securities in which we can potentially invest
  - **Return definition**
    - ✓ in what currency the return should be computed
      - ◆translate all investment returns into one single currency
      - ◆denominate returns in local currencies
    - ✓ The benchmark used is often the benchmark for the client mandate or fund for which the investment strategy under study is applicable.

Backtesting Process

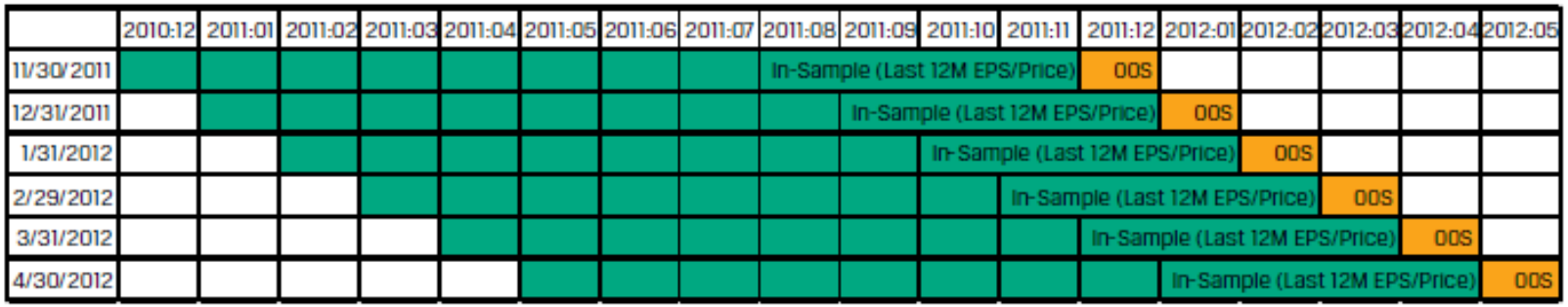
- **Key parameters**
  - **Rebalancing frequency and transaction cost**
    - ✓ Practitioners often use a monthly frequency for portfolio rebalancing
    - ✓ daily or higher frequency rebalancing typically incurs higher transaction costs
  - **Start and end date**
    - ✓ All else equal, investment managers prefer to backtest investment strategies using as long a history as possible
    - ✓ performance over a long data history should be supplemented with examinations of discrete regimes within the long history using historical scenario analysis

Backtesting Process

➢ Historical investment simulation

- To simulate rebalancing, analysts typically use **rolling windows**, in which a portfolio or strategy is constituted at the beginning of a period using data from a historical in-sample period, followed by testing on a subsequent, out-of-sample period (OOS). The process is repeated as time moves forward and replicates the live investing process, because investment managers adjust their positions as new information arrives

Exhibit 2 Rolling Window Backtesting of the Earnings Yield Factor



Backtesting Process

➢ Analysis of backtesting output

- Analyst often use **metrics** such as the Sharpe ratio, the Sortino ratio, volatility, and maximum drawdown (the maximum loss from a peak to a trough for an asset or portfolio), other key performance ouputs are **visual**
- It is also useful to examine the backtested cumulative performance of an investment strategy over an extended history, plotting performance using a logarithmic scale is recommended.
- Backtesting implicitly assumes that the past is likely to repeat itself, but this assumption does not fully account for the dynamic nature of financial markets, which may include extreme upside and downside risks that have never occurred before.
  - ✓ Stuctural breaks(regime changes) are one reason

3. Problems in Backtesting

- **Look-ahead bias**
  - Using information that was unknown or unavailable during the historical periods over which the backtest is conducted.
  - Survivorship bias is a type of look-ahead bias, it can be overcome by using point-in-time data.
  - It is likely the most common mistake that practitioners make when performing backtesting.
  - Look-ahead bias has several common forms:
    - ✓ **reporting lags,**
    - ✓ **revisions,** and
    - ✓ **index additions**

Problems in Backtesting

- **Look-ahead bias**
  - **Reporting lags**
    - ✓ in conducting a backtest for year-end 2018, EPS results for the quarter ending 31 December 2018 are unavailable until 2019.
    - ✓ to avoid look-ahead bias, analysts typically compensate by adding several months of reporting lag for every company
  - **Data revisions**
    - ✓ Macroeconomic data are often revised multiple times, and companies often re-state their financial statements.

Problems in Backtesting

- **Look ahead bias**
  - **Index Additions**
    - ✓ Data vendors add new companies to their databases. An analyst backtesting with the current database would be using information on companies that were not actually in the database during the backtesting period.
    - ✓ **Survivorship bias** refers to deriving conclusions from data that reflects only those entities that have survived to that date.
      - ◆ **Point-in-time data** allow analysts to use the most complete data for any given prior time period, thereby enabling the construction (and backtesting) of the most realistic investment strategies

Problems in Backtesting

- **Data Snooping (p-hacking)**
  - making an inference after looking at statistical results rather than testing a prior inference
  - It occurs when an analyst selects data or performs analyses until a significant result is found
  - Data snooping may be mitigated by setting a much higher hurdle than typical.
    - ✓ t-statistic>3, to assess whether a new factor is indeed adding value.
  - Another technique to detect and mitigate data snooping is cross validation. Rolling window backtesting is a form of cross-validation.
    - ✓ the analyst partitions the dataset into training data and validation data and tests a model built from the training data on the validation data

4. Historical Scenario Analysis

- **Historical scenario analysis** is a type of backtesting that explores the performance and risk of an investment strategy in different structural regimes and at structural breaks.
- **Regime change**
  - Expansions and recessions
  - High-and low volatility regimes

5. Simulation

- **Historical simulation**: construct results by selecting returns at random from many different historical periods (windows) without regard to time-ordering.
  - The problem with historical time-series data is that there is only one set of realized data to draw from, but most financial variables are not stationary.
- In **Monte Carlo simulation**, each key variable is assigned a statistical distribution, and observations are drawn at random from the assigned distribution.
  - Advantage: highly flexible
  - Disadvantage: complex and computationally intensive
- Simulation is especially useful in measuring the downside risk of investment strategies.

Simulation

➢ Historical simulation

- Backtesting and historical simulation are different in that rolling-window backtesting is deterministic, whereas historical simulation incorporates randomness rather than following each period chronologically.
- First, a decision must be made about whether to sample from the historical returns with replacement (**bootstrapping**) or without replacement.
  - ✓ Bootstrapping is used because the number of simulations needed is often larger than the size of the historical dataset.
- Then perform a historical simulation (eight steps)

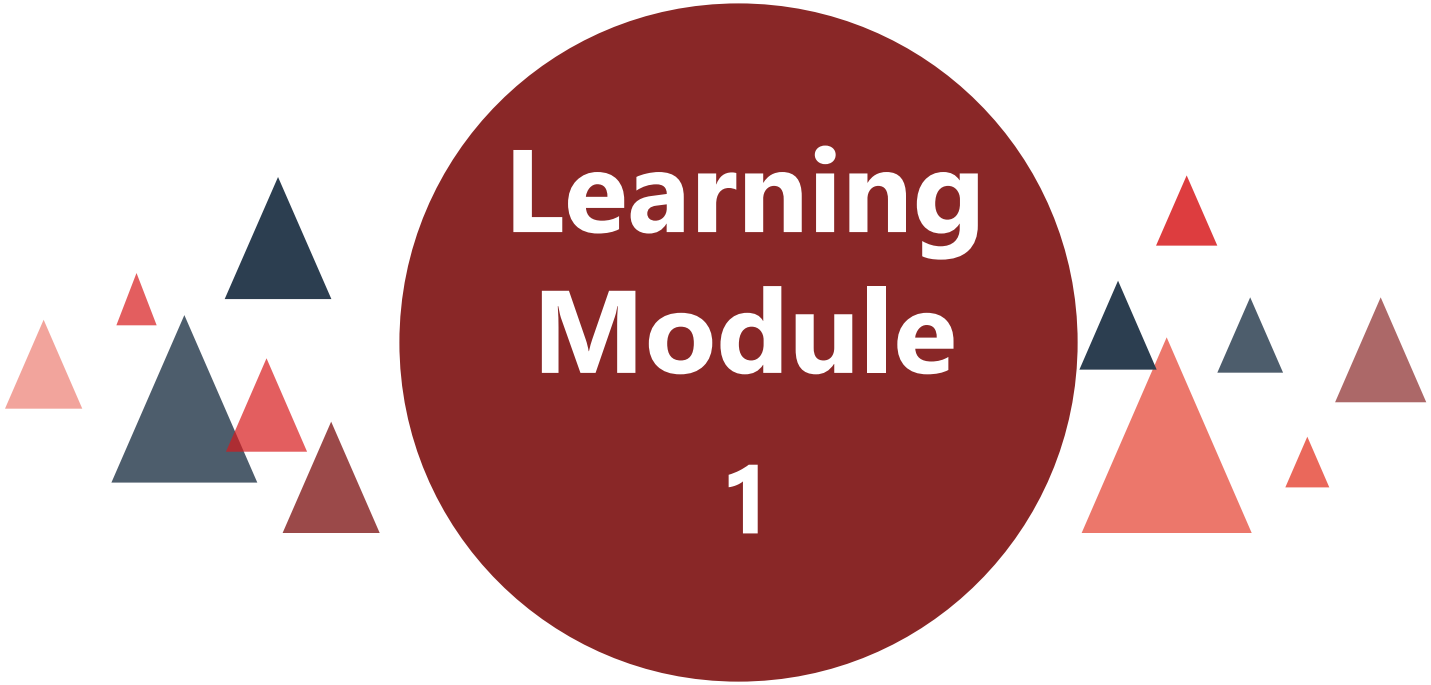
Simulation

➢ Monte Carlo simulation

- First, we need to specify a functional form for each key decision variable
  - ✓ Regression and distribution-fitting techniques are used to estimate the parameters underlying the statistical distributions of the key decision variables. This step is called **model calibration**.
- Considerations for the functional form of the statistical distribution:
  - ✓ The distribution should reasonably describe the key empirical patterns of the underlying data.
  - ✓ It is equally critical to account for the correlations between multiple key decision variables, use multivariate distribution rather than modeling each factor or asset on a standalone basis.
  - ✓ The complexity of the functional form and number of parameters that determine the functional form are important.

6. Sensitivity Analysis

- **Sensitivity analysis** is a technique for exploring how a target variable is affected by changes in input variables (e.g., the distribution of asset or factor returns)
- Monte Carlo simulation fits a multivariate normal distribution, which fails to account for negative skewness and fat tails. We should conduct a sensitivity analysis by fitting our factor return data to a different distribution and repeating the Monte Carlo simulation accordingly
  - One alternative to test is a multivariate skewed Student's t-distribution, it has the ability to account for the skewness and the excess kurtosis.



Economics and investment markets

Economics and investment markets

- Real default-free interest rate
  - ✓ Inter-temporal rate of substitution
  - ✓ Covariance term
  - ✓ 影响因素
- Nominal default-free interest rate
  - ✓ Breakeven rate
  - ✓ 影响因素
- Credit premiums
- Equity risk premium
- Commercial real estate

Framework

- **The present value model**

$$P_t^i = \sum_{s=1}^{N} \frac{E_t\left[\widetilde{CF}_{t+s}^i\right]}{\left(1 + l_{t,s} + \theta_{t,s} + \rho_{t,s}^i\right)^s}$$

- where:

P^i_t = the value of the asset *i* at time *t* (today)

N = number of cash flows in the life of the asset

$\widetilde{CF}^i_{t+s}$ = the uncertain, nominal cash flow paid *s* periods in the future

$E_t\left[\widetilde{CF}\right]$ = the expectation of the random variable *CF* conditional on the information available to investors today (*t*)

$l_{t,s}$ = yield to maturity on a ***real default-free*** investment today (*t*), which pays one unit of currency *s* periods in the future

$\theta_{t,s}$ = ***expected inflation rate*** between *t* and *t* + *s*

$\rho^i_{t,s}$= the risk premium required today (*t*) to pay the investor for taking on risk in the cash flow of asset *i*, *s* periods in the future (***uncertainty about the asset's future cash flows***, e.g., credit risk, liquidity risk)

1. The Discount Rate on Real Default-free Bonds

- In this case, the investor can:
  - Pay price $P_{t,s}$ today, t, of a default –free bond paying 1 monetary unit of income s periods in the future, or
  - Buy goods worth $P_{t,s}$ dollars today.
- **Inter-temporal rate of substitution (m)** is the ratio of the *marginal utility of consumption periods s in the future (the numerator) to the marginal utility of consumption today (the denominator)*.
  - The Inter-temporal rate of substitution was **lower** at **good state** of the economy. (prefer current consumption)
  - The **marginal utility of consumption** of investors ***diminishes*** as their ***wealth increases*** because they already satisfied fundamental needs.

One-Period Zero-Coupon Bond

- The investor must make the decision today based on her expectations of future circumstances.

$$P_{t,s} = E_t[1\tilde{m}_{t,s}] = E_t[\tilde{m}_{t,s}]$$

  - If this ***price of the bond was less than*** the investor's expectation of ***the inter-temporal rate of substitution***, then she would ***prefer to buy more of the bond today***.

- If the investment horizon for this bond is one year, and the payoff then is \$1, the return on this bond can be written as the future payoff minus the current payment relative to the current payment.

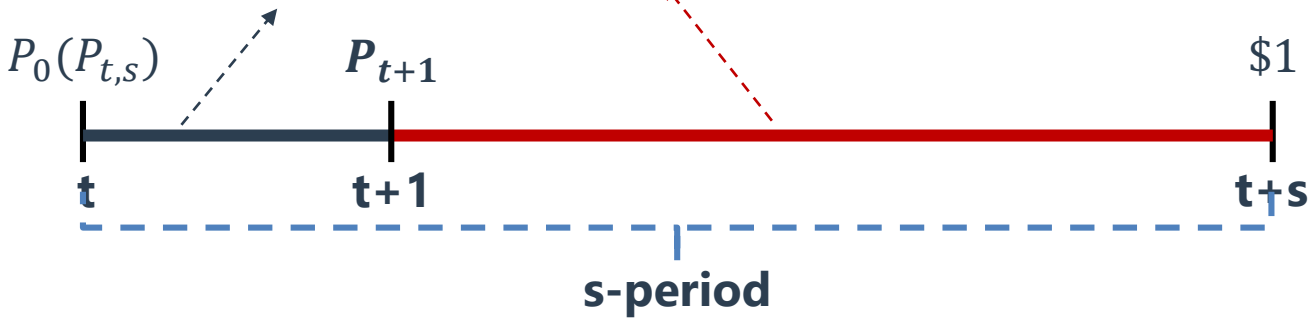
$$The\ return\ on\ this\ bond = l_{t,1} = \frac{1-P_{t,1}}{P_{t,1}} = \frac{1}{E_t[\tilde{m}_{t,1}]} - 1$$

  - ***The one-period real risk-free rate is inversely related to the inter-temporal rate of substitution.***

The Discount Rate on Real Default-free Bonds

- **Pricing a s-period Default-Free Bond**

$$P_{t,s} = \frac{E_t\left[\tilde{P}_{t+1,s-1}\right]}{1 + l_{t,1}} + cov_t\left[\tilde{P}_{t+1,s-1}, \tilde{m}_{t,1}\right]$$



  - The covariance term is the discount for risk.
    - ✓ A one-period default-free bond, the covariance term is zero
    - ✓ The **covariance term** for most risky assets is expected to be **negative**.
    - ✓ However, the covariance term can be **positive** when economy goes bad.
- Higher trend real economic growth, higher real default-free interest rates.
- GDP growth is more volatile, the higher default-free real interest rates are.

2. Nominal Interest Rate

- **The pricing formula for a default-free nominal coupon-paying bond**

$$P_t^i = \sum_{s=1}^{N} \frac{CF_{t+s}^i}{(1 + l_{t,s} + \theta_{t,s} + \pi_{t,s})^s}$$

  - Expected inflation : $\theta_{t,s}$.
  - Uncertainty related to future inflation = π_t.
  - Break-even inflation rates = $\theta_{t,s} + \pi_t$
- Short-term default-free interest rates tend to be very heavily influenced by:
  - **Inflation environment** and **inflation expectations** over time
  - **Real economic activity**.
  - **Central bank's policy rate**

Taylor Rule

- **Taylor rule**
  - $Policy\ rate_t = l_t + \iota_t + 0.5(\iota_t - \iota^*_t) + 0.5(Y_t - Y^*_t)$
    - ✓ l_t is the level of real short-term interest rates that balance long-term savings and borrowing in the economy
    - ✓ ι_t is the rate of inflation
    - ✓ ι^*_t is the target rate of inflation
    - ✓ Y_t and Y^*_t are, respectively, the logarithmic levels of actual and potential real GDP
  - The difference between Y_t and Y^*_t is known as the "**output gap**".
    - ✓ When the ***output gap is positive***, it implies that the economy is producing beyond its sustainable capacity.
    - ✓ When the ***output gap is negative***, it implies that the economy is producing below its sustainable capacity.
  - **Neutral policy rate:** the policy rate that neither spurs on nor impedes real economic activity.
    - ✓ $\iota_t = \iota^*_t$
    - ✓ Output gap = 0

3. Credit Premium

- **Credit-risky bonds (corporate bond)**

$$P_t^i = \sum_{s=1}^{N} \frac{E[\widetilde{CF_{t+s}^i}]}{\left(1 + l_{t,s} + \theta_{t,s} + \pi_{t,s} + \gamma_{t,s}^i\right)^s}$$

- **Credit spread:** the difference between the yield on a corporate bond and that on a government bond with the same currency denomination and maturity.
- Credit risky bonds share the same risk as default-free bonds, which market participants often refer to as interest rate risk, but they also embody **credit risk, $\gamma_{t,s}^i$**.
- Bonds spreads do tend to ***rise*** in the lead up to and ***during a recession***, and to ***decline*** once the economy ***comes out of recession***.

Business Cycle

- **Industry sector and credit quality**
  - Credit spreads between corporate bond sectors with **different ratings** will often have very different sensitivities to the business cycle.
  - Some **industrial sectors** are more sensitive to the business cycle than others. This sensitivity can be related to the types of goods and services that they sell or to the indebtedness of the companies in the sector.
- **Company-specific factors:**
  - Issuers that are profitable, have low **debt** interest payments, and that are not heavily reliant on debt financing will tend to have a high credit rating because their ability to pay is commensurately high.

4. Equities and The Equity Risk Premium

- **Equity risk premium**

$$P_t^i = \sum_{s=1}^{N} \frac{E_t\left[\widetilde{CF}_{t+s}^i\right]}{\left(1 + l_{t,s} + \theta_{t,s} + \pi_{t,s} + \gamma_{t,s}^i + \kappa_{t,s}^i\right)^s}$$

- Equity risk premium,$\lambda_{t,s}^i$, is equal to $\gamma_{t,s}^i + \kappa_{t,s}^i$. (相对于国债)
- $\kappa_{t,s}^i$ is essentially the ***equity premium relative to credit risky bonds***. This is not the way the equity risk premium is usually expressed.
  - We would expect the *equity premium to be larger* than the credit premium.
  - The two premiums will tend to be *positively correlated* over time, and will tend to be influenced by the business cycle in similar ways.
  - **Equities are a bad hedge for bad consumption outcomes**, so *equity risk premium should be positive*

5. Commercial Real Estate

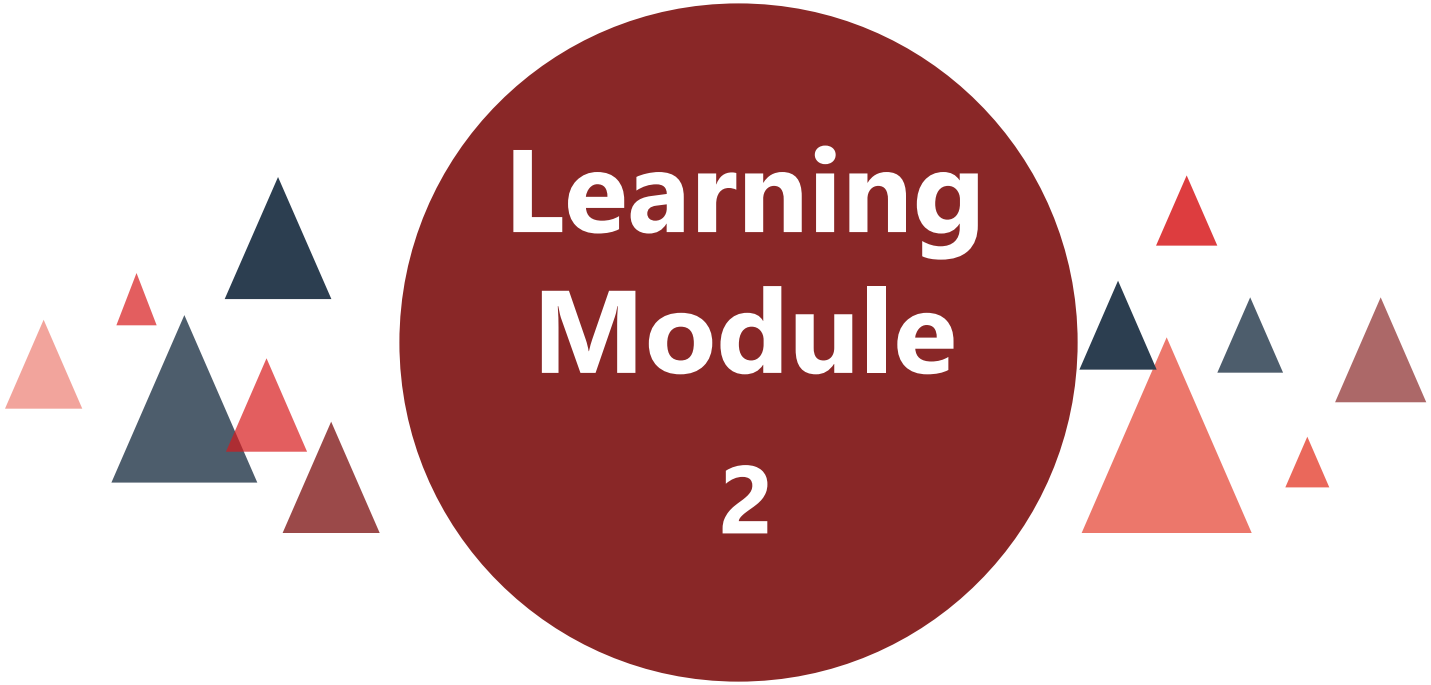
- **Regular cash flow**
  - **Bond-like: rent income**
    - ✓ Analogous to coupon income
    - ✓ The credit quality of a commercial property portfolio will be determined by ***the credit quality of the underlying tenants***.
  - **Equity-like: value of property**
    - ✓ The value of the property will arguably be determined by two key factors: the property's location and the state of the underlying economy. There is uncertainty related to sell it.
  - **Illiquidity**
- **The pricing formula for commercial real estate**

$$P_t^i = \sum_{s=1}^{N} \frac{E_t\left[\widetilde{CF}_{t+s}^i\right]}{\left(1 + l_{t,s} + \theta_{t,s} + \pi_{t,s} + \gamma_{t,s}^i + \kappa_{t,s}^i + \phi_{t,s}^i\right)^s}$$

  - $\phi_{t,s}^i$ represent liquidity risk premium.

Commercial Real Estate and The Business Cycle

- **Nominal rental income** might be relatively ***stable***.
- The **capital values of commercial property** are ***highly sensitive to the economic environment***.
  - A ***recession*** will generally cause these values to ***fall*** whereas more robust economic conditions will tend to cause commercial property prices to rise, often dramatically.
  - The ***pro-cyclical nature*** of commercial property prices means that investors will generally demand a ***relatively high risk premium***.
    - ✓ Commercial property does ***not appear to be a very good hedge*** against bad economic outcomes.



Analysis of Active Portfolio Management

Analysis of active portfolio management

- Decomposition of value added
- Constructing optimal portfolios
  - ✓ IR & SR （性质）
  - ✓ Optimal active risk
  - ✓ Adjust active risk
- Fundamental law
  - ✓ Information coefficient & Transfer coefficient
  - ✓ Forecasted active return & optimal active weight
  - ✓ The basic & full fundamental law
  - ✓ Ex post performance measurement

1. Decomposition of Value Added

- **Definition:**
  - **Active return (value added)**
    - ✓ $R_A = R_P - R_B$
  - **Alpha**
    - ✓ A risk-adjusted calculation of value added, which we will refer to as the managed portfolio's alpha
    - ✓ $\alpha_A = R_P - \beta_p R_B$

Decomposition of Value Added

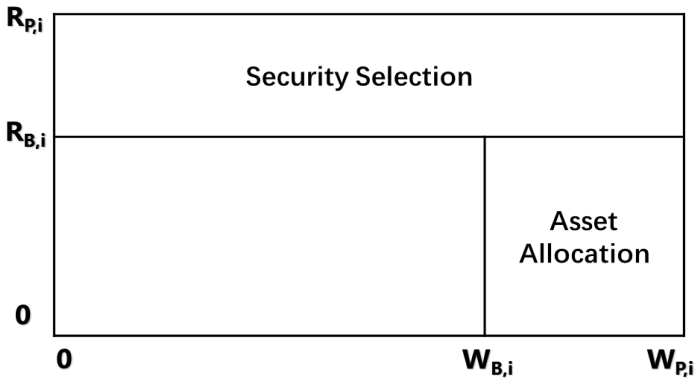
- **Measuring value added**
  - **Active weights**: $\Delta\omega_i = \omega_{P,i} - \omega_{B,i}$
    - ✓ ***The sum of the active weights is zero***
  - **Active return (value added):**
    - ✓ $R_A = R_P - R_B$
    - ✓ $R_A = \sum_{i=1}^{N} \Delta\omega_i R_{Ai}$, where $R_{Ai}=R_i-R_B$
    - ✓ Positive value added is generated when securities that have returns greater than the benchmark are overweighted and securities that have returns less than the benchmark are underweighted.

Decomposition of Value Added

- The common decomposition: value added due to **asset allocation** and value added due to **security selection**.
- The total value added is the difference between the actual portfolio and the benchmark return:

$$R_A = \sum_{j=1}^{M} w_{P,j}(R_{P,j} - R_{B,j}) + \sum_{j=1}^{M} (w_{P,j} - w_{B,j})R_{B,j}$$

Security Selection **Asset Allocation**



2. Constructing optimal portfolios

- Sharpe ratio
  - The Sharpe ratio measures reward per unit of risk in absolute returns.
  - An important property is that the Sharpe ratio is ***unaffected*** by the addition of cash or leverage in a portfolio.
  - $\sigma_C = w_P \sigma_P$
- Information ratio
  - The information ratio is ***affected*** by the addition of cash or the use of leverage.
  - The information ratio of an unconstrained portfolio is ***unaffected*** by the aggressiveness of active weights.
  - $\sigma_A^C = w_p \sigma_A^P$

Constructing optimal portfolios

- Given the opportunity to adjust absolute risk and return with cash or leverage, the **overriding objective** is to find the single risky asset portfolio with the **maximum Sharpe ratio**.
  - The squared Sharpe ratio of an actively managed portfolio is equal to the squared Sharpe ratio of the benchmark plus the information ratio squared:

$$\mathrm{SR_P^2} = \mathrm{SR_B^2} + \mathrm{IR}^2 \qquad \sigma_P^2 = \sigma_B^2 + \sigma_A^2$$

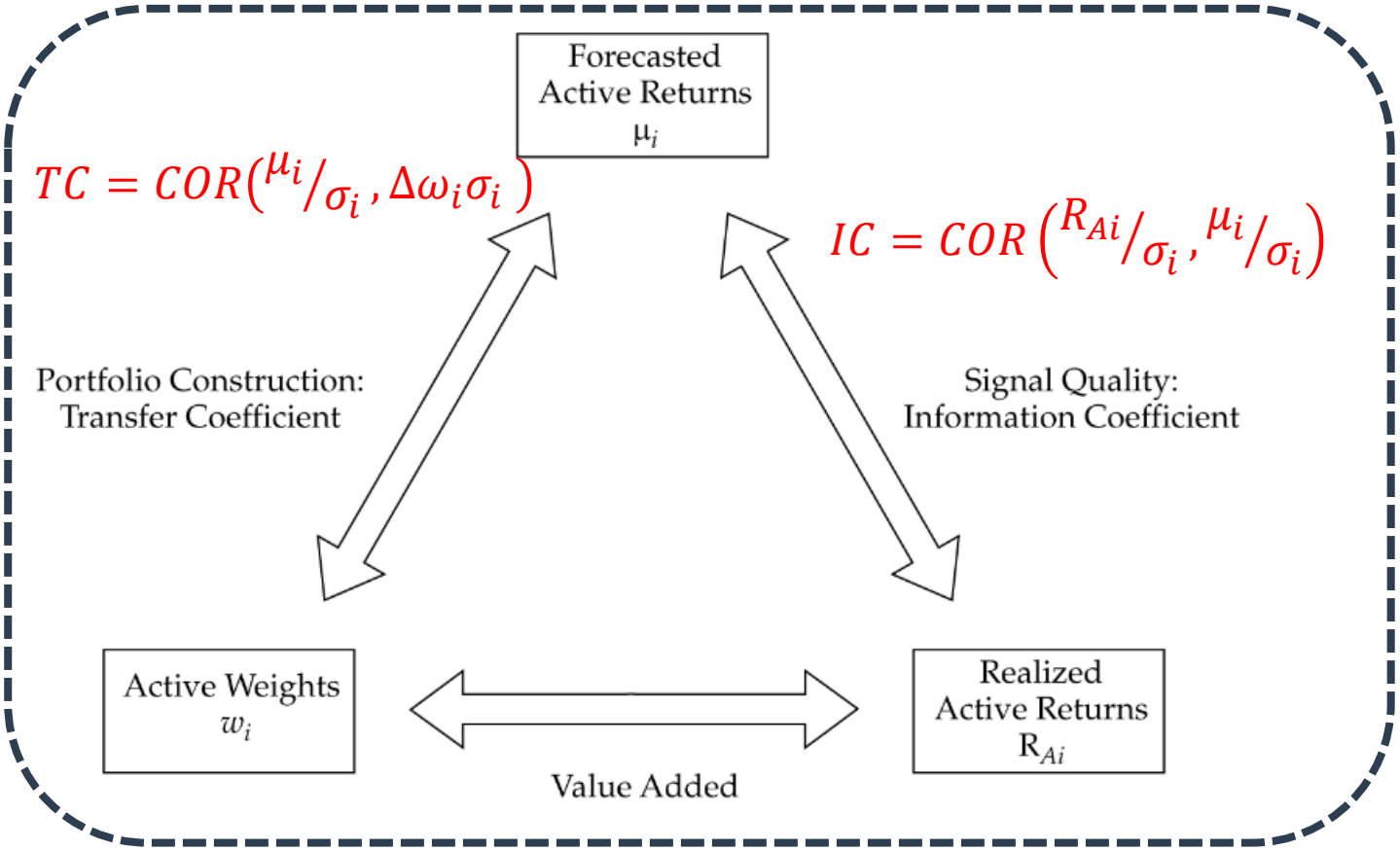
    - ✓ Active portfolio with the highest (squared) information ratio will also have the highest (squared) Sharpe ratio?
  - For unconstrained portfolios, the level of active risk that leads to the optimal portfolio is:

$$\sigma_{\mathrm{R_A}} = \frac{\mathrm{IR}}{\mathrm{SR_B}} \sigma_{\mathrm{R_B}}$$

    - ✓ Blended portfolio: investing in both the actively managed and benchmark portfolios.

3. Fundamental law

- **The Correlation Triangle (参数、计算)**



BR, or **breadth**, is equal to the number of ***independent decisions*** made ***per year*** by the investor in constructing the portfolio.

Fundamental Law

- **The basic fundamental law**

$$IR^* = IC \times \sqrt{BR}$$

$$E(R_A)^* = IC\sqrt{BR}\sigma_A$$

- **The full fundamental law**

$$IR = (TC)(IC)\sqrt{BR}$$

$$E(R_A) = (TC)(IC)\sqrt{BR}\sigma_A$$

It’s not the end but just beginning.

Life is short. If there was ever a moment to follow your passion and do something that matters to you, that moment is now.

生命苦短，如果你有一个机会跟随自己的激情去做你认为重要的事，那么这个机会就是现在。

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
    - ✓ 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
  - 请发送电子邮件至：academic.support@gfedu.net
- **非常感谢您对金程教育的支持，您的每一次反馈都是我们成长的动力。**后续我们也将开通其他问题反馈渠道（如微信等）。