Asset Allocation and Related Decisions in Portfolio Management

CFA三级培训项目

讲师：Jcy

101% Contribution Breeds Professionalism

Jcy CFA/AQF/FRM/RFP

- 工作职称：金程教育高级合伙人， 金程教育资深培训师，金程教育金融建模、量化投资(AQF)课程开发负责人
- 工作背景：金融行业从业经验丰富，曾先后就职于中国建设银行、中信证券等知名金融机构。对企业IPO、投资理财、量化投资等领域有着深入的研究和独到的见解。
- 服务客户：中国工商银行、中国银行、中国建设银行、上海银行、兴业银行、中国人民银行研究生部、兴业证券、平安证券、南京证券、湘财证券、上海证券交易所、深圳综合开发研究院、山东省银行同业协会、中国CFP标准委员会、杨浦区党校、太平洋保险、泰康人寿、中国人寿、人保资产管理、中国平安、华夏基金
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Topic in CFA Level III

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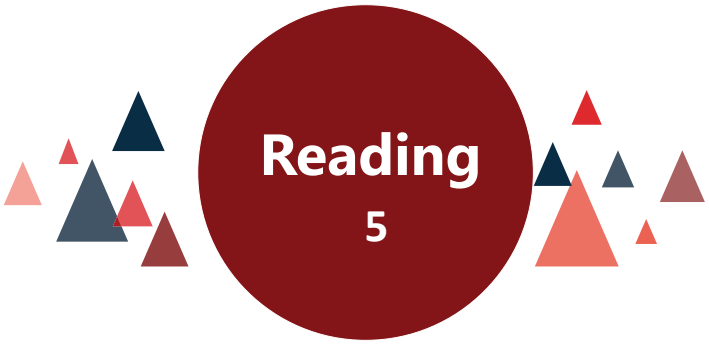
Framework

Asset Allocation and Related Decisions in Portfolio Management

SS3: Asset Allocation and Related Decisions in Portfolio Management

- R5: Overview of Asset Allocation
- R6: Principles of Asset Allocation
- R7: Asset Allocation with Real-World Constraints



Overview of Asset Allocation

Framework

1. Investment governance
2. Economic balance sheet
3. Asset allocation approaches
   - Asset only
   - Liability Relative
   - Goal based
4. Strategic asset allocation
5. Strategic implementation choices
6. Strategic considerations in rebalancing

1. Investment Governance

- **Investment governance**
  - The organization of decision-making responsibilities;
  - Oversight of processes;
  - Ensure decisions are made with the necessary skills and capacity;
- **Differences with management**

Governance	Management
■ Clarifying the mission ■ Creating a plan ■ Reviewing progress toward achieving long- and short-term objectives	■ The execution of the plan to achieve the agreed-on goals and objectives

- **Levels within governance hierarchy**
  - Governing investment committee
  - Investment staff
  - Third-party resources

Investment Governance

- **The governance audit**
  - **Purpose:** ensure that the established policies, procedures, and governance structures are effective.
  - **Performed by:** independent third party
- **Good governance**
  - Ensures the durability or survivability of the investment program
    - ✓ Avoid decision-reversal risk
    - ✓ Consider the effect of investment committee member and staff turnover on the durability of the investment program
    - ✓ Prevent key person risk
  - Assures accountability

2. Economic Balance Sheet

- **Economic balance sheet**
  - Conventional/Financial assets and liabilities
  - **Additional/Extended assets and liabilities**
    - ✓ Relevant in making asset allocation decisions but not appear on conventional balance sheets

Assets	Liabilities and Net worth
Financial assets	***Financial liabilities***
Domestic equity	Short-term borrowing
Extended assets	***Extended liabilities***
PV of expected future contributions	PV of expected future support
	Net worth
	Economic net worth

Economic Balance Sheet

- **Extended portfolio assets**
  - **For individual investors**
    - ✓ **Human capital** (The PV of future earnings)
    - ✓ The PV of pension income
    - ✓ The PV of expected inheritances
  - **For institutional investors**
    - ✓ Underground mineral resources
    - ✓ The PV of future intellectual property royalties
- **Extended portfolio liabilities**
  - **For individual investors**
    - ✓ The PV of future consumption
  - **For institutional investors**
    - ✓ The PV of prospective payouts for foundations

Example

- The Laws have worked their entire careers at Whorton Solutions (WS), a multinational technology company and they have two teenage children who will soon begin college.
- The Laws have an investment portfolio consisting of $800,000 in equities and $450,000 in fixed-income instruments. 80% of the equity portfolio consists of shares of WS. The Laws also own real estate valued at $400,000, with $225,000 in mortgage debt. The Laws' pre-retirement earnings from WS have a total present value of $1,025,000, and their future expected consumption expenditures have a total present value of $750,000.
- The Laws express a very strong desire to fund their children's college education expenses, which have an estimated present value of $275,000. The Laws also plan to fund an endowment at their alma mater in 20 years, which has an estimated present value of $500,000.

Example

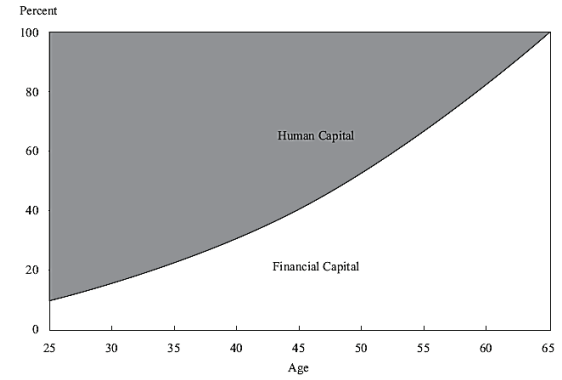
- Using the economic balance sheet approach, the Laws' economic net worth is *closest* to:
  A. $925,000
  B. $1,425,000
  C. $1,675,000
- **Correct Answer: A.**

Assets		**Liabilities and Net worth**	
Financial assets		*Financial liabilities*	
Fixed income	450,000	Mortgage debt	225,000
Real estate	400,000	*Extended liabilities*	
Equity	800,000	Children's education	275,000
Extended assets		Endowment funding	500,000
Human capital	1,025,000	PV of consumption	750,000
		Economic Net worth	925,000

Economic Balance Sheet

- Exhibit 3 illustrates a typical path for the **composition of an individual's economic balance sheet** from age 25 through age 65.

Exhibit 3 Human Capital (HC) and Financial Capital (FC) relative to Total Wealth



Economic Balance Sheet

- **Life-cycle balanced funds** (also known as **target date funds**) are examples of investments that seek to coordinate **asset allocation with human capital**.

Exhibit 4 Glide Path of Target Date Investment Funds in One Family

Assumed Age	Equity Allocation	Bond Allocation
25	85%	15%
35	82	18
45	77	23
55	63	37
65	49	51

Note: Allocations as of 31 December 2009.
Source: Based on data in Idzorek, Stempien, and Voris (2013).

3. Approaches to Asset Allocation

- **Three broad approaches to asset allocation**
  - **Asset-only:** Mean–variance optimization (MVO)
    - ✓ focus solely on the asset side of the investor's balance sheet
  - **Liability-relative:** Funding liabilities
    - ✓ provide for the money to pay liabilities when they come due
    - ✓ **Liability-driven investing (LDI)** is an investment industry term that generally encompasses asset allocation that is focused on funding an investor's liabilities
  - **Goals-based:** Achieving the goals
    - ✓ specify asset allocations for sub-portfolios, each of which is aligned to specified goals ranging from supporting lifestyle needs to aspirational
    - ✓ **Goals-based investing (GBI)** is an investment industry term that encompasses the asset allocation focused on addressing an investor's goals

3.1 Distinctions Between Liabilities

- **Liability-relative: Distinctions between liabilities for an institutional investor and goals for an individual investor**
  - Liabilities of institutional investors are legal obligations or debts, whereas goals, such as meeting lifestyle or aspirational objectives, are not.
  - Whereas **institutional liabilities**, such as life insurer obligations or pension benefit obligations, are uniform in nature (all of a single type), an **individual's** goals may be many and varied.
  - Liabilities of **institutional investors** of a given type (e.g., the pension benefits owed to retirees) are often numerous and so, through averaging, may often be forecast with confidence. In contrast, **individual goals** are not subject to the law of large numbers and averaging.

3.2 Relevant Objectives

Asset Allocation Approach	Relation to Economic Balance Sheet	Typical Objective	Typical Uses and Asset Owner Types
Asset-only	Does not explicitly model liabilities or goals	Maximize Sharpe ratio for acceptable level of volatility	Liabilities or goals not defined and/or simplicity is important ■ Some foundations, endowments ■ Sovereign wealth funds ■ Individual investors
Liability-relative	Models legal and quasi-liabilities	Fund liabilities and invest excess assets for growth	Penalty for not meeting liabilities high ■ Banks ■ Defined benefit pensions ■ Insurers
Goals-based	Models goals	Achieve goals with specified required probabilities of success	Individual investors

3.3 Risk Concepts

- **Asset-only**
  - Primary measure of risk: volatility (standard deviation) of portfolio return
  - Other risk sensitivities:
    - ✓ Risk relative to benchmarks: tracking risk (tracking error)
    - ✓ Downside risk
      - semi-variance
      - peak-to-trough maximum drawdown
      - measures focusing on the extreme (tail) segment of the downside: Value at risk (VaR)
- **Liability-relative**
  - Shortfall risk
  - Volatility of contributions needed to fund liabilities
- **Goal-based**
  - Maximum acceptable probability of not achieving a goal

3.4 Asset Class

- **Criteria for specifying asset classes for the purpose of asset allocation**
  - Assets within an asset class should be relatively **homogeneous**;
  - Asset classes should be **mutually exclusive**;
  - Asset classes should be **diversifying**;
  - The asset classes as a group should make up a **preponderance of world investable wealth**;
  - Asset classes selected for investment should have the capacity to absorb a **meaningful proportion of an investor's portfolio**.

Example

- In reviewing a financial plan written by the Laws' previous adviser, Raye notices the following asset class specifications.
  - Equity: US equities
  - Debt: Global investment-grade corporate bonds and real estate
  - Derivatives: Primarily large-capitalization foreign equities
- The previous adviser's report notes the asset class returns on equity and derivatives are highly correlated. The report also notes the asset class returns on debt have a low correlation with equity and derivative returns.
- Raye believes the previous adviser's **specification for debt** is incorrect given that, for purposes of asset allocation, asset classes should be:
  A. diversifying.
  B. mutually exclusive.
  C. relatively homogeneous.
- **Correct Answer: C**

3.5 Risk Factor

- **Asset-based asset allocation**
  - Modeling using asset classes as the unit of analysis tends to obscure the portfolio's sensitivity to overlapping risk factors;
    - ✓ Risk factor exposures may overlap across multiple asset classes. The overlaps help explain the correlation of asset classes.
- **Use multifactor risk models** have been labeled "**factor-based asset allocation**" can be used for asset allocation by creating factor portfolios.
- **The process of factor-based asset allocation**
  - Specify risk factors and the desired exposure to each factor;
  - Describe asset classes with respect to their sensitivities to each of the factors;
  - Construct factor portfolios that isolate exposure to the risk factor;
  - Map back a choice of risk exposures in factor space to asset class space for implementation.

Risk Factor

- **How risk factor exposures can be achieved by long and short positions or use existing instrument.**
  - **Inflation.** Going long nominal Treasuries and short inflation-linked bonds isolates the inflation component.
  - **Credit spread.** Going long high-spread credit bond and short Treasuries/government bonds isolates credit exposure.
  - **Duration.** Going long 10+ year Treasuries and short 1–3 year Treasuries isolates the duration exposure being targeted.
  - **Real interest rates.** Inflation-linked bonds provide a proxy for real interest rates.
  - **US volatility.** VIX (Chicago Board Options Exchange Volatility Index) futures provide a proxy for implied volatility.

Example

- An investment adviser is concerned that the asset allocation approach followed by his client's previous financial adviser resulted in an overlap in risk factors among asset classes for the portfolio. To address his concern regarding the previous adviser's asset allocation approach, he should assess his client's portfolio using:
  A. a homogeneous and mutually exclusive asset class–based risk analysis.
  B. a multifactor risk model to control systematic risk factors in asset allocation.
  C. an asset class–based asset allocation approach to construct a diversified portfolio.

- **Correct Answer: B**

3.6 Global Market Portfolio

- **Global market portfolio** sums all investable assets (global stocks, bonds, real estate, and so forth) held by investors, and reflects the balancing of supply and demand across world markets.
  - Minimize diversifiable risk
  - As a reference point for a highly diversified portfolio
  - The available portfolio that makes the most efficient use of the risk budget
  - Mitigate investment biases, such as home-country bias
- **Global market-value weighted portfolio should be considered as a baseline asset allocation.**

4. Strategic Asset Allocation

- **Strategic asset allocation / Policy portfolio**
  - an asset allocation that is expected to be effective in achieving an asset owner's investment objectives, given his or her investment constraints and risk tolerance, as documented in the investment policy statement
- **Optimal asset allocation**

$$\underset{\text{by choice of asset class weights } w_i}{\text{Maximize}} \; E[U(W_T)] = f\left(W_0, w_i, \begin{matrix}\text{asset class return distributions,}\\ \text{degree of risk aversion}\end{matrix}\right)$$

subject to $\sum_{i=1}^{n} w_i = 1$ *and any other constraints on* w_i

- **Utility function**
  - Mean-variance utility:

$$U = E(r_p) - \frac{1}{2}\lambda\sigma_p^2$$

Strategic Asset Allocation

- **Optimal Choice in the Simplest Case**
  - The simplest asset allocation decision problem involves one risky asset and one risk-free asset.
  - Let λ, μ, r_f, and σ^2 represent, respectively, the investor's degree of risk aversion, the risk asset's expected return, the risk-free interest rate, and the variance of return. With mean–variance utility, the **optimal allocation to the risky asset, w***, can be shown to equal:

$$w^* = \frac{1}{\lambda}\left(\frac{\mu - r_f}{\sigma^2}\right)$$

  - The allocation to the risky asset is inversely proportional to the investor's risk aversion and directly proportional to the risk asset's expected return per unit of risk (represented by return variance).

Example: 2018 Q9-A

- An investment adviser is counseling a client who recently inherited €1,200,000 and who has above-average risk tolerance (λ = 2). The exhibit below shows three alternative strategic asset allocations.

	Investor's Forecasts	
Asset Allocation	Expected Return	Standard Deviation of Return
A	10.00%	20%
B	7.00%	10%
C	5.25%	5%

- Based only on Goddard's risk-adjusted expected returns for the asset allocations, which asset allocation would she prefer?

Example

➢ **Solution:**

Using the utility function $U = E(r_p) - \frac{1}{2}\lambda\sigma_p^2 = E(r_p) - \frac{1}{2}\times 2\times\sigma_p^2 = E(r_p) - \sigma_p^2$

The client's utility for Asset Allocations A, B, and C are as follows:

U_A=10.0%-(20%)^2=6.0%

U_B=7.0%-(10%)^2=6.0%

U_C=5.25%-(5%)^2=5.0%

The client would be indifferent between A and B based only on their common perceived certainty-equivalent return of 6%.

5. Strategic Implementation Choices

➢ **Two dimensions of passive/active choices**
- Passive/active management of the strategic asset class weights;(whether to deviate from the SAA tactically or not)
- Passive and active management of allocations to asset classes.

➢ **Passive/Active Management of Allocations to Asset Classes**
- Passive does not react to changes in the investor's CME or insights into individual investments;
- Active will respond to changing CME or insights resulting in changes to portfolio composition.

➢ **Tactical asset allocation (TAA) and dynamic asset allocation (DAA)**
- **Tactical asset allocation (TAA)** involves deliberate short-term deviations from the strategic asset allocation;
- **Dynamic asset allocation (DAA):** a strategy incorporating deviations from the strategic asset allocation that are motivated by longer-term valuation signals or economic views.

Strategic Implementation Choices

➢ **Passive/Active Spectrum**

MOST PASSIVE (indexing to market weights)	Use of information on asset classes, investment factors, and individual investments increases is often quantified by → Increasing tracking risk relative to benchmark → → Increasing active share relative to benchmark →	MOST ACTIVE (unconstrained mandates)

➢ **Factors influencing where to invest on the passive/active spectrum**
- Available investments;
- Scalability of active strategies being considered;
- The feasibility of investing passively while incorporating client-specific constraints(e.g. ESG investing criteria);
- Beliefs concerning market informational efficiency;
- The trade-off of expected incremental benefits relative to incremental costs and risks of active choices;
- Tax status.

6. Strategic Considerations in Rebalancing

- **Rebalancing** is the discipline of adjusting portfolio weights to more closely align with the strategic asset allocation.
- **Approaches to rebalancing**
  - Calendar rebalancing: on a periodic basis
  - Percent-range rebalancing (range-based rebalance)
    - ✓ Trigger points or Rebalance range (or corridor)

Strategic Considerations in Rebalancing

- **Factors affecting the optimal corridor width of an asset class (Without weighing costs and benefits in the abstract)**
  - **Positively related to optimal corridor width**
    - ✓ **Transaction costs**: High transaction costs set a high hurdle for rebalancing benefits to overcome.
    - ✓ **Risk tolerance**: Higher risk tolerance means less sensitivity to divergences from the target allocation.
    - ✓ **Correlation with the rest of the portfolio**: When asset classes move in sync, further divergence from target weights is less likely.
  - **Inversely related to optimal corridor width**
    - ✓ **Volatility of the rest of the portfolio**: Higher volatility makes large divergences from the strategic asset allocation more likely.
    - ✓ An asset class's own volatility: Higher volatility makes large divergence from the strategic asset allocation more likely.

Strategic Considerations in Rebalancing

- **Strategic considerations**

Considerations	Rebalancing ranges
Transaction costs	Higher costs, wider ranges
Risk-aversion	More risk-averse, narrower ranges
Asset class correlation	Less correlated, narrower ranges in case further divergence
Beliefs in momentum favor/ mean reversion	Beliefs in momentum, wider ranges; Mean reversion, narrower ranges
Liquidity	Illiquid investments, typically associated with larger trading costs, encourage wider ranges
Volatility	Higher volatility makes divergences from the strategic asset allocation more likely, thus narrower ranges
Taxes	Encourage asymmetric and wider rebalancing ranges, for example, 25%->(24%,28%)

Strategic Considerations in Rebalancing

- **Frequency of the portfolio valued**
  - The narrower corridor, the more frequent rebalance
  - The more frequent the monitoring, the greater the precision in implementation
  - More frequent rebalancing, higher cost
- **Fully or partially correcting**
  - Rebalance back to target weights
  - Rebalance to range edge
  - Rebalance halfway between the range-edge trigger point and the target weight

Strategic Considerations in Rebalancing

- **Disciplined rebalancing has tended to reduce risk while incrementally adding to returns.**
  - Rebalancing earns a diversification return.
    - ✓ The compound growth rate of a portfolio is greater than the weighted average compound growth rates of the component portfolio holdings (given positive expected returns, positive asset weights, and sufficiently low transaction costs).
  - Rebalancing earns a return from being short volatility.
    - ✓ In the case of a portfolio consisting of a risky asset and a risk-free asset, the return to a rebalanced portfolio can be replicated by creating a buy-and-hold position in the portfolio, writing out-of-the-money puts and calls on the risky asset, and investing the premiums in risk-free bonds.
    - ✓ As the value of puts and calls is positively related to volatility, such a position is called being short volatility (or being short gamma, by reference to the option Greeks).

Reading 6

Principles of Asset Allocation

Framework

1. Developing asset-only asset allocations
   - MVO
     - Process
     - Corner portfolio
     - Criticisms of MVO
   - Addressing the Criticisms of MVO
     - Add constraints
     - Resampled MVO
     - Reverse optimization
     - Black-Litterman model
     - Non-normal optimization
     - Factor-based model
     - MCS
2. Developing liability-relative asset allocation
3. Developing goals-based asset allocations
4. Heuristics and other approaches
5. Risk budgeting and Risk Party

1.1 Asset-Only: MVO

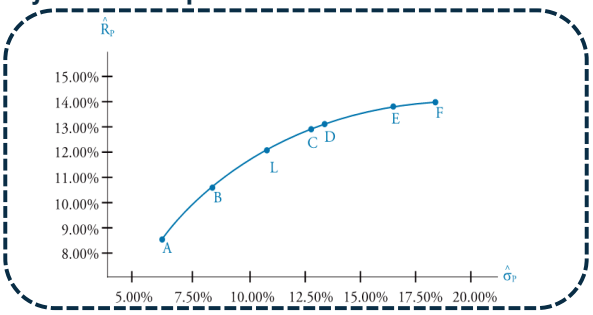
- MVO requires three sets of inputs: returns, risks (standard deviations), and pair-wise correlations for the assets in the opportunity set, and the objective function expressed as follows:

$$U_{\mathrm{m}} = E(\mathrm{R}_{m}) - 0.005\lambda\sigma_{\mathrm{m}}^{2}$$

- There are some issues to consider:
  - Non-constraint vs no negative weights;
    - ✓ The simplest optimization places no constraints on asset class weights except the budget constraint that weights sum to 1.
    - ✓ The non-negativity constraint leads to corner-portfolio EF.
  - Only risky asset vs separating out cash and cash equivalent as risk-free asset (non-constraint).
    - ✓ Cash is treated as risky asset → risky-asset EF
    - ✓ Cash and cash equivalent are treated as risk-free assets → linear EF (CML)

Corner Portfolio

- **With short sale restrictions**, the frontier changes from a smooth curve to one with corner portfolios
- A **corner portfolio** is formed when the weights of an asset go from zero to positive or vice versa
  - No negative weights
- We can approximate the standard deviation for an efficient portfolio given those of **adjacent corner portfolios**



Example

- An endowment's return objective is 7%, which includes a spending rate of 3%
- Given the corner portfolio returns on the next slide and assuming no short sales, **determine the standard deviation and asset weights for the portfolio that will meet their objective**.

Corner Portfolio	E(R)	σ	Sharpe Ratio	Asset A Weight	Asset B Weight	Asset C Weight
1	9%	16%	0.436	100%	0%	0%
2	7.5%	11.5%	0.478	80%	20%	0%
3	5.5%	7.7%	0455	0%	40%	60%
4	5.3%	7.6%	0.434	0%	0%	100%

Example

- **Asset Class Contributions**
  - Portfolio 2 and 3 are adjacent corner portfolios.
    - ✓ $\omega_2 \times 7.5\% + \omega_3 \times 5.5\% = 7\%, \quad \omega_2 + \omega_3 = 1$
    - ✓ Calculate: $\omega_2 = 75\%, \omega_3 = 25\%$
  - To calculate how much the strategic portfolio invests in assets A, B, and C, use the 75/25 weights in Corner Portfolios 2 and 3:
    - ✓ $\omega_A = 75\% \times 80\% + 25\% \times 0\% = 60\%$
    - ✓ $\omega_B = 75\% \times 20\% + 25\% \times 40\% = 25\%$
    - ✓ $\omega_C = 75\% \times 0\% + 25\% \times 60\% = 15\%$
- **Estimating the Standard Deviation**
  - The approximate standard deviation of the portfolio is a weighted average of the standard deviations of Corner Portfolios 2 and 3:
  - $\sigma_P = 0.75(0.115) + 0.25(0.077)$
    $\sigma_P = 0.1055 = 10.55\%$
  - Note that the estimate is an upper it to the true standard deviation
    - ✓ Does not account for diversification (correlation)

Corner Portfolio

- **Introducing a Risk-Free Asset**
  - If there is a **risk-free asset** available, combining it with the corner portfolio with the **highest Sharpe ratio** can increase the investor's utility
    - ✓ This is equivalent to combining the risk-free asset with the tangency portfolio
    - ✓ In capital market theory, the market portfolio (i.e., the tangency portfolio) has the highest available Sharpe ratio of any portfolio on the efficient frontier
  - If the return on the corner portfolio with highest Sharpe ratio is greater than the required return, hold positive weights of the corner portfolio and the risk free asset
  - If its return is less than the required return, borrow at the risk-free rate to lever up the return
    - ✓ This assumes no restrictions on leverage

Example

- **Calculating the Portfolio Weights**
  - In our example, **Corner Portfolio 2 has the highest Sharpe ratio**
  - Given a return objective of 7%, risk-free rate of 2%, solve for the weights of Corner Portfolio 2 and R_F:

$$0.07 = 0.075w_2 + 0.02(1 - w_2)$$

$$w_2 = 0.909;\ w_{RF} = 0.091$$

  - Put 90.9% of the value of the portfolio in Corner Portfolio 2 and 9.1% in the risk-free asset
- **Calculating the Standard Deviation**
  - the portfolio standard deviation is determined as follow:

$$\sigma_P = 0.909(0.115)+0.091(0)$$

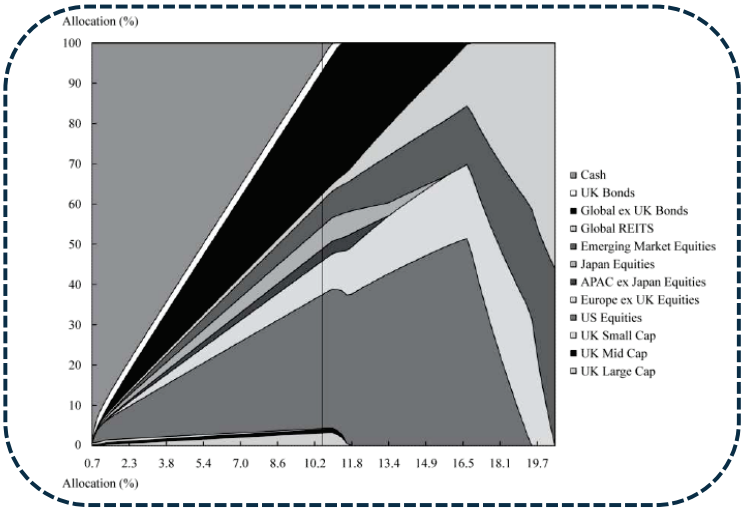
$$\sigma_P = 0.1045 = 10.45\%$$

Asset-Only: MVO

- **Strengths**
  - Most common and widely used
  - Basis for more sophisticated approaches
- **Weaknesses**
  - The outputs (asset allocations) are **highly sensitive to small changes in the inputs**; (**other approaches**)
  - The asset allocations tend to be **highly concentrated in a subset** of the available asset classes; (**other approaches**)
  - Investors are often concerned with characteristics of asset class returns such as **skewness and kurtosis that are not accounted** for in MVO; (**Non-normal optimization approaches**)
  - While the asset allocations may appear diversified across assets, the sources of **risk may not be diversified**; (**Factor-based model**)
  - MVO allocations may have no direct connection to the factors affecting any **liability or consumption streams**; (**ALM**)
  - MVO is **a single-period framework** that does not take account of trading/ rebalancing costs and taxes. (**MCS**)

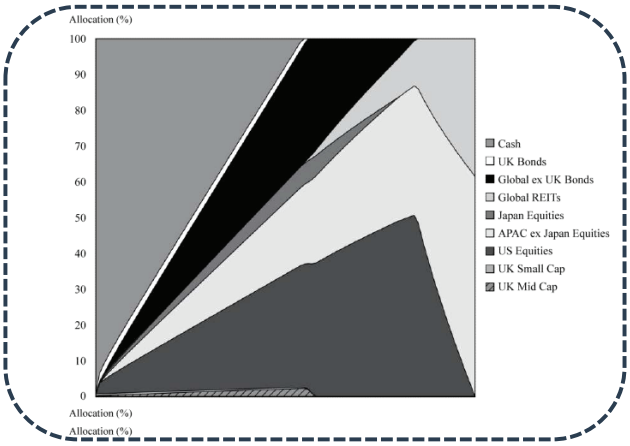
Asset-Only: MVO

- **Efficient Frontier Asset Allocation Area Graph—Base Case**



Asset-Only: MVO

- **Efficient Frontier Asset Allocation Area Graph—Changed Expected Returns**
  - Increased the expected return of Asia Pacific ex Japan equities from 8.5% to 9.0% and decreased the expected return of Europe ex UK equities from 8.6% to 8.1%



1.2 Addressing Criticisms - Adding Constraints

- There are two primary reasons (**advantage**) practitioners typically apply additional constraints:
  - To incorporate real-world constraints into the optimization problem ;
  - And to help overcome some of the potential shortcomings of mean–variance optimization elaborated above (input quality, input sensitivity, and highly concentrated allocations).
- **Disadvantage**: If a very large number of constraints are imposed, one is no longer optimizing but rather specifying an asset allocation through a series of binding constraints.

Addressing Criticisms - Adding Constraints

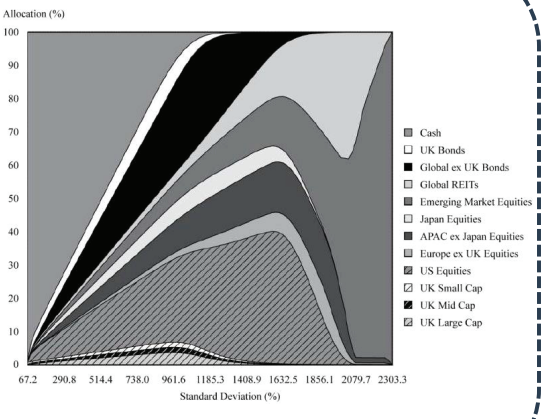
- When running an optimization, in addition to the typical budget constraint and the non-negativity constraint, one can impose additional constraints.
  - **Specify a set allocation to a specific asset**
    - ✓ 30% to real estate or 5% to private equity
  - **Specify an asset allocation range for an asset**
    - ✓ The emerging market allocation must be between 5% and 20%.
  - **Specify an upper limit, due to liquidity considerations**
    - ✓ Such as private equity or hedge funds
  - **Specify the relative allocation of two or more assets**
    - ✓ The allocation to emerging market equities must be less than the allocation to developed equities

1.3 Addressing Criticisms - Resampled MVO

- Resampled mean–variance optimization **combines Markowitz's mean–variance optimization framework with Monte Carlo simulation** and, all else equal, leads to more-diversified asset allocations.
  - Resampling uses MCS to estimate a large number of potential capital market assumptions for MVO, which lead to an equal number of MVO frontiers, also referred to as simulated frontiers.
  - The resulting asset allocations, or portfolio weights, from these simulated frontiers are saved and averaged (using a variety of methods), and, eventually, for the **resampled frontier**.

Addressing Criticism - Resampled MVO

- **Criticisms including the following:**
  - Some frontiers have concave "bumps" where expected return decreases as expected risk increases;
  - The "riskier" asset allocations are over-diversified;
  - The asset allocations inherit the estimation errors in the original inputs; and
  - The approach lacks a foundation in theory.



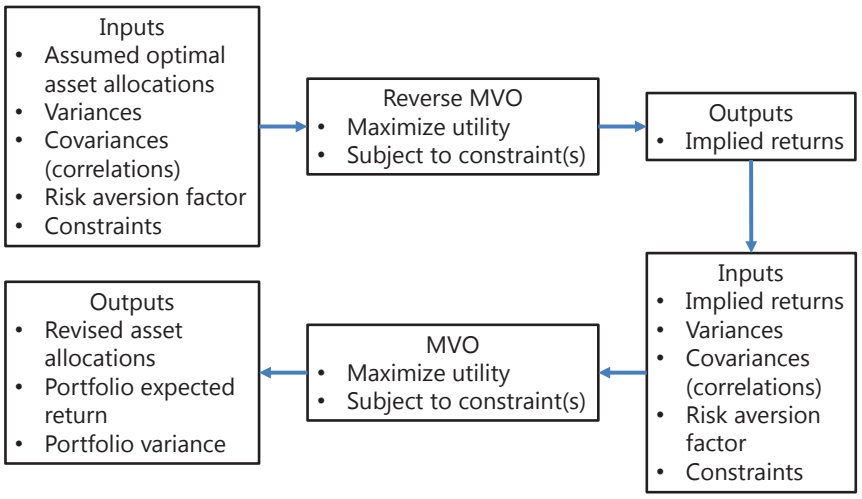
Efficient Frontier Asset Allocation Area Graph, Returns with Resampling

1.4 Addressing Criticisms - Reverse Optimization

- **Reverse optimization** is a powerful tool that helps explain the implied returns associated with any portfolio. It can be used to estimate expected returns for use in a forward-looking optimization.
- Reverse optimization takes as its **inputs a set of asset allocation weights of global market portfolio** that are assumed to be optimal and with additional inputs of covariance and the risk aversion coefficient, solves for expected returns (also called **implied returns**).

Addressing Criticisms - Reverse Optimization

- The process is depicted below.



Addressing Criticisms - Reverse Optimization

- Some practitioners will find the link between reverse optimization and CAPM equilibrium elegant.
  - First, use the weights associated with the asset classes (or various indexes) to form a working version of the global market portfolio;
  - And use the beta of each asset relative to our working version of the global market portfolio;
  - Then to infer what expected returns would be if all assets were priced by the CAPM according to their market beta. Where, we assume a risk-free rate of 2.5% and a global market risk premium of 4%;
  - Run a new MVO.

1.5 Addressing Criticisms - BL Model

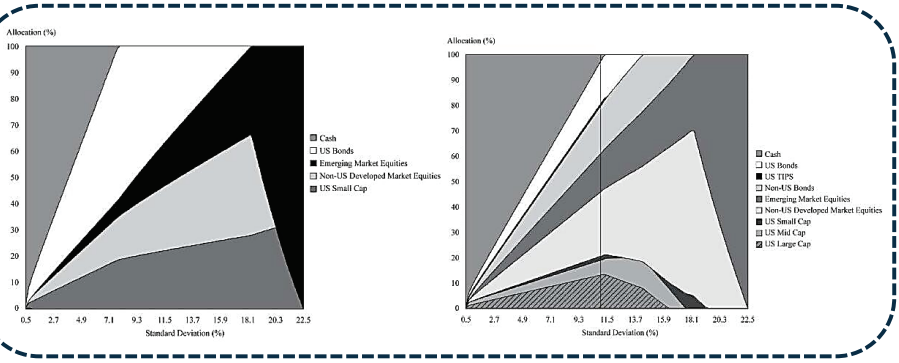
- The **Black–Litterman model** has helped make the MVO framework more useful. It **enables investors to combine their unique forecasts of expected returns** with reverse optimized returns in an elegant manner.
  - Starts with excess returns (in excess of the risk-free rate) produced from reverse optimization;
  - And then provides a technique for altering reverse-optimized expected returns in such a way that they reflect an investor's own distinctive views.
  - A new MVO is run.
- Deriving expected returns by reverse optimization or by reverse optimization tilted toward an investor's views on asset returns (the Black-Litterman model) is one means of addressing the tendency of MVO to produce efficient portfolios that are not well diversified.
- **Reverse optimization and the Black–Litterman model** address the issue of MVO's sensitivity to small differences in expected return estimates by anchoring expected returns to those implied by the asset class weights of a proxy for the global market portfolio.

Addressing Criticisms - BL Model

Exhibit 13 Comparison of Black–Litterman and Reverse-Optimized Returns

Asset Class	Reverse-Optimized Returns	Black–Litterman Returns	Difference
UK large cap	6.62%	6.60%	–0.02%
UK mid cap	6.92	6.87	–0.05
UK small cap	7.08	7.03	–0.05
US equities	7.81	7.76	–0.05
Europe ex UK equities	8.62	8.44	–0.18
Asia Pacific ex Japan equities	8.53	8.90	0.37
Japan equities	6.39	6.37	–0.02
Emerging market equities	8.96	9.30	0.33
Global REITs	9.02	9.00	–0.01
Global ex UK bonds	4.03	4.00	–0.03
UK bonds	2.94	2.95	0.01
Cash	2.50	2.50	0.00

Examples



- Identify three techniques that the asset allocations in Panel B might have incorporated to improve the characteristics relative to those of Panel A.
  - To achieve the better-diversified efficient frontier shown in Panel B, several methods might have been used, including reverse optimization, the Black–Litterman model, and constrained asset class weights.

1.6 Addressing Criticisms-Non-Normal Optimization

- **A normal distribution** is fully explained by the first two moments because the skewness and (excess) kurtosis of the normal distribution are both zero.
- Unfortunately, variance or standard deviation is an incomplete measure of risk when returns are not normally distributed. Investor preferences may go beyond the first two moments (**mean and variance**) of a portfolio's return distribution. The third and fourth moments are, respectively, skewness and kurtosis.
  - **Skewness** measures the degree to which return distributions are asymmetrical
  - **Kurtosis** measures the thickness of the distributions' tails (i.e., how frequently extreme events occur)
- A number of variations of these more sophisticated optimization techniques have been put forth, most of them **consider the non-normal return distribution characteristics** and use a more sophisticated definition of risk, such as:
  - Mean–semivariance optimization
  - Mean–conditional value-at-risk optimization
  - Mean–variance-skewness optimization
  - Mean–variance-skewness-kurtosis optimization

1.7 Asset-Only: Factor-Based Model

- Factor-based asset allocation also requires three sets of inputs: returns, risks (standard deviations), and pair-wise correlations for **these factors in the opportunity set**, in order to get an optimized solution.
  - MVO and more sophisticated approaches that overcome some of the limitations or weaknesses of as applied to an opportunity set consisting of traditional, non-overlapping asset classes.
  - An alternative approach used by some practitioners is to move away from an opportunity set of asset classes to an opportunity set consisting of investment factors, or factor-based asset allocation.

Asset-Only: Factor-Based Model

- **The factors** are typically similar to the fundamental (or structural) factors in widely used multi-factor investment models. Typical factors used in asset allocation include size, valuation, momentum, liquidity, duration (term), credit, and volatility.
  - Returns can be combined from shorting large-cap stocks and going long small-cap stocks, for an example, "**Size factor return = Small-cap stock return – Large-cap stock return**".
  - Standard deviations represent the volatility of different factors' return.
  - Pair-wise correlations with the market and with one another are generally low. Constructing factors in this manner removes most market exposure from the factors because of the short positions that offset long positions.

Asset-Only: Factor-Based Model

Exhibit 20 Factors/Asset Classes, Factor Definitions, and Historical Statistics (US data, January 1979 to March 2016)

Factor/Asset Class	Factor Definition	Compound Annual Factor Return	Standard Deviation	Total Return	Standard Deviation
Treasury bonds	Long-term Treasury bonds			7.77%	5.66%
Market	Total market return – Cash	7.49%	16.56%	12.97	17.33
Size	Small cap – Large cap	0.41	10.15	5.56	10.65
Valuation	Value – Growth	0.68	9.20	5.84	9.76
Credit	Corporate – Treasury	0.70	3.51	5.87	3.84
Duration	Long Treasury bonds – Treasury bills	4.56	11.29	9.91	11.93
Mortgage	Mortgage-backed – Treasury bonds	0.30	3.38	5.45	3.83
Large growth	—	—	—	12.64	19.27
Large value	—	—	—	13.23	16.52
Small growth	—	—	—	12.30	25.59
Small value	—	—	—	14.54	19.84
Mortgage-backed sec.	—	—	—	8.09	6.98
Corporate bonds	—	—	—	8.52	7.52
Treasury bonds	—	—	—	7.77	5.66
Cash	—	—	—	5.13	1.23

1.8 Asset-Only: MCS

- **Monte Carlo simulation complements** MVO by addressing the limitations of MVO as a **single-period** framework.
- MCS can help **paint a realistic picture of potential future outcomes**, including the likelihood of meeting various goals, the distribution of the portfolio's expected value through time, and potential maximum drawdowns.
- Monte Carlo simulation can effectively **grapple with a range of practical issues** that are difficult or impossible to formulate analytically.
  - **Rebalancing and taxes**: In the multi-period world, rebalancing triggers the realization of capital gains and losses. Given a specific rebalancing rule, different SAAs will result in different patterns of tax payments.
  - **Path dependent**: Investors save/deposit money in and spend money out of their portfolios; thus, in the more typical case, terminal wealth is path dependent because of the interaction of cash flows and returns.

1.9 Liquidity Considerations

- **Definition**
  - **Liquid asset classes**: such as publicly listed equities and bonds.
  - **Less liquid asset classes**: such as direct real estate, infrastructure, and private equity.
- **When make asset-allocation decisions, there are two problems for the less liquid asset classes:**
  - Due to the lack of accurate indexes, it is more challenging to make capital market assumptions for these less liquid asset classes
  - Even if there were accurate indexes, there are no low-cost passive investment vehicles to track them.

Liquidity considerations

- **In addressing asset allocation involving less liquid asset classes, practical options include the following:**
  - (1) Exclude less liquid asset classes from the asset allocation decision and then consider real estate funds, infrastructure funds, and private equity funds as potential implementation vehicles when fulfilling the target strategic asset allocation.
  - (2) Include less liquid asset classes in the asset allocation decision and attempt to model the inputs to represent the specific risk characteristics associated with the likely *implementation vehicles*.
  - (3) Include less liquid asset classes in the asset allocation decision and attempt to model the inputs to represent the highly diversified characteristics associated with the true asset classes.
    - ✓ Use listed real estate indexes, listed infrastructure, and public equity indexes that are deemed to have characteristics similar to their private equity counterparts to help estimate the risk of the less liquid asset classes and their correlation with the other asset classes in the opportunity set.

Framework

1. Developing asset-only asset allocations
2. Developing liability-relative asset allocation
   - Surplus optimization
   - Hedging\return-seeking portfolio
   - Integrated asset-liability approach
3. Developing goals-based asset allocations
4. Heuristics and other approaches
5. Risk budgeting and Risk Party

2. Liability-relative Asset Allocations

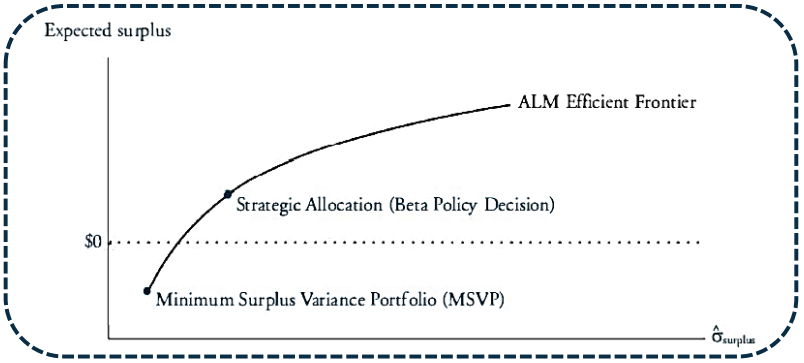
- Liability-relative asset allocation is aimed at the general issue of rendering decisions about asset allocation in conjunction with the investor's liabilities.
  - Liability-relative investors view assets as an inventory of capital, which is available to achieve goals and to pay future liabilities.
  - Were developed in **an institutional investor** context, but these ideas have also been applied to individual investors.
    - ✓ Because many large institutional investors possess legal liabilities and operate in regulated environments in which an institution's inability to meet its liabilities with current capital has serious consequences.
- **Liability-relative Asset Allocations Methods include:**
  - Surplus optimization
  - Hedging/Return-seeking Portfolio Approach
  - Integrated asset-liability Approach

2.1 Surplus Optimization

- It involves adapting asset-only mean–variance optimization to an efficient frontier based on **the volatility of surplus by substituting surplus return for asset return** over any given time horizon, all else equal.
  - Is a straightforward extension of the asset-only portfolio model
  - The objective function is $U_{LR\mathrm{m}} = E(\mathrm{R}_{s,m}) - 0.005\lambda\sigma^2_{(\mathrm{R}_{s,m})}$
  - Where, Surplus Return = (Change in asset value – Change in liability value)/(Initial asset value)
- **Expected returns and variances of liabilities**
  - We assume that the liabilities have the same expected returns and volatilities as US corporate bonds;
  - An alternative approach is to deploy a set of underlying factors that drive the returns of the assets.

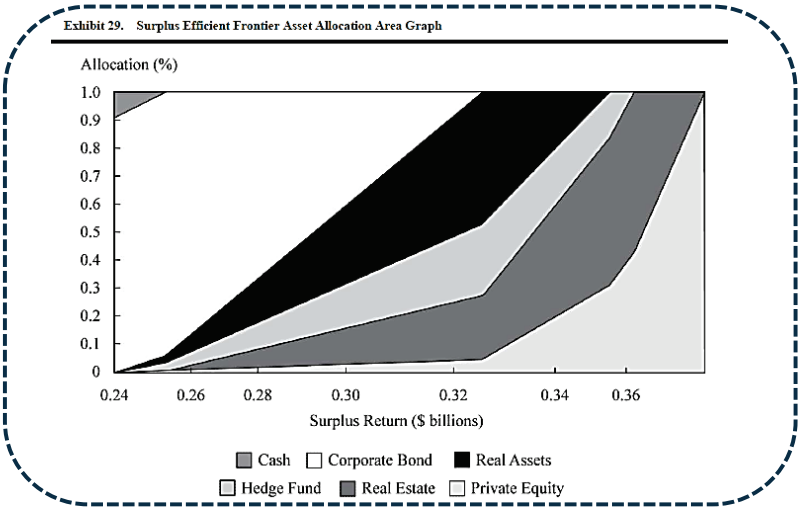
Surplus Optimization

- Asset liability management (ALM) considers the allocation of assets with respect to a given liability or set of liabilities.
- The ALM approach maximize the difference (the surplus) between assets and liabilities at each level of risk (much like the efficient frontier represents the maximum return at each level of risk).



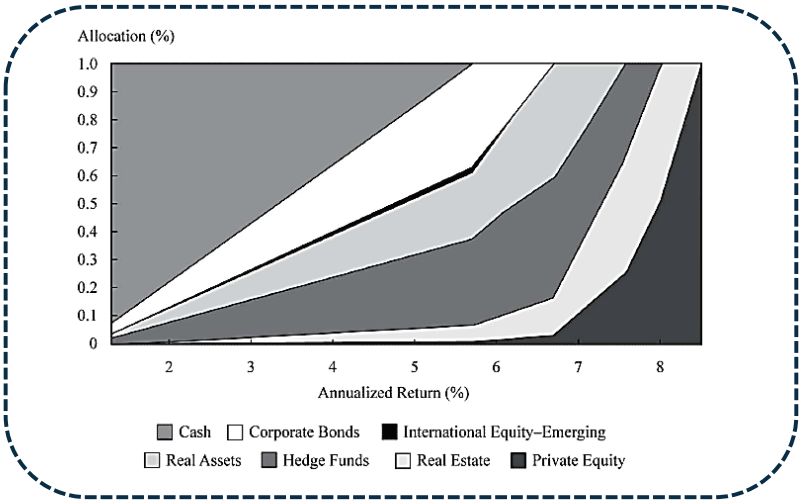
Surplus Optimization

- **Surplus Efficient Frontier Asset Allocation**



Surplus Optimization

- **Asset-Only Efficient Frontier Asset Allocation**



Surplus Optimization

- **The comparison between the two asset mixes (asset-only and surplus):**
  - The asset mixes are very different on the **conservative side** of the two frontiers.
    - ✓ The most conservative mix for the **surplus efficient frontier** consists mostly of the US corporate bond index because it results in the lowest volatility of surplus over the one-year horizon.
    - ✓ In contrast, the most conservative mix for the **asset-only efficient frontier** consists chiefly of cash.
  - The two asset mixes (asset-only and surplus) become similar as the degree of risk aversion decreases, and they are identical for the most aggressive portfolio (private equity).
  - Bonds disappear from the frontier about halfway between the most conservative and the most aggressive mixes.

2.2 Hedging/Return-Seeking Portfolio Approach

- In this approach, the liability-relative asset allocation task is divided into two parts, thus this approach is also called **two-portfolio approach**.
  - We distinguish as **"basic" the two-portfolio approach** in the case in which there is **a surplus**
    - ✓ In the basic case, the first part of the asset allocation task consists of hedging the liabilities through a **hedging portfolio**. In the second part, the surplus (or some part of it) is allocated to a **return-seeking portfolio**, which can be **managed independently** of the hedging portfolio (e.g. using MVO).
  - And as "**variants**" the approach as applied when there is **not a positive surplus**
    - ✓ A **partial hedge**, whereby capital allocated to the hedging portfolio is reduced in order to generate higher expected returns
    - ✓ And dynamic versions whereby the investor increases the allotment to the hedging portfolio as the funding ratio increases.

Hedging/Return-Seeking Portfolio Approach

- **Compared to basic approach**
  - These **variants** do not hedge the liabilities to the full extent possible given the assets and thus are **less conservative** than the basic approach discussed above.
  - Still, there can be benefits to a partial hedge when the sponsor is able to **increase contributions** if the funding ratio does not increase in the future to 1 or above.
- **An essential issue involves the composition of the hedging portfolio**
  - The designated cash flows can be hedged via cash flow matching, duration matching, or immunization, e.g. frozen DB pension plan.
  - What's the most important is the hedging portfolio must include assets whose returns are driven by the **same factors** that drive the returns of the liabilities.

Hedging/Return-Seeking Portfolio Approach

- **Limitations and ways of addressing these problems:**
  - First, **if the funding ratio is less than 1, the investor cannot create a fully hedging portfolio** unless there is a sufficiently large positive cash flow (contribution).
    - ✓ In this case, the sponsor might increase contributions enough to generate a positive surplus.
    - ✓ Or applications of variants of the two-portfolio approach are possible, such as partial hedge variant.
  - A second barrier occurs when a **true hedging portfolio is unavailable**. An example involves losses due to weather-related causes, such as hurricanes or earthquakes.
    - ✓ In these cases, the investor might be able to partially hedge the portfolio with instruments that share some of the same risks. The investor has "basis risk" when imperfect hedges are employed.
    - ✓ As an aside, the investor might be able to set up a contract with someone who, for a fee, will take on the liability risk that cannot be hedged. Insurance contracts have this defining characteristic.

Example: 2018 Q9-B

- Sarzi was recently hired as the investment advisor for the ZTA Corporation pension fund. The current market value of the pension fund's assets is USD 10 billion, and the present value of the fund's liabilities is USD 8 billion. The fund has been managed using an asset-only approach, but Sarzi recommends that the risk-averse ZTA board of directors consider adopting a liability-relative method, specifically the hedging/return-seeking portfolio approach.
- Sarzi assumes that the returns of the fund's liabilities are driven by changes in the returns of index-linked government bonds. Exhibit presents three potential asset allocation choices for the pension fund.

Example: 2018 Q9-B

Potential Asset Allocation Choices for ZTA Corporation's Pension Fund			
Asset Class	Allocation 1	Allocation 2	Allocation 3
Cash	30%	0%	5%
Index-lined government bonds	50%	80%	10%
Corporate bonds	10%	5%	25%
Equities	10%	15%	60%
Portfolio Statistics			
Expected return	3.5%	3.9%	6.4%
Expected standard deviation	6.8%	7.8%	12.1%

- **Determine** which asset allocation would be most appropriate for the pension fund given Sarzi's recommendation. **Justify** your response.

Example: 2018 Q9-B

- **Correct Answer: Allocation B**
- The pension fund currently has a **surplus of USD 2 billion** (USD 10 billion – USD 8 billion) where USD 8 billion is the present value of the fund's liabilities.
- To adopt a hedging/return-seeking portfolio approach, the board would **first hedge the liabilities** by allocating an amount equal to the present value of the fund's liabilities, **USD 8 billion, to a hedging portfolio**. The hedging portfolio must include assets whose returns are driven by the **same factors** that drive the returns of the liabilities, which in this case are the **index-linked government bonds**. So, the board should **allocate 80%** (USD 8 billion / USD 10 billion) of the fund's assets to index-linked government bonds.
- The residual **USD 2 billion surplus** would then be invested into a **return-seeking portfolio**.
- **Allocation 2 is the most appropriate asset allocation** for the fund because it allocates 80% of the fund's assets to index-linked government bonds, and the remaining 20% of fund assets in a return-seeking portfolio consisting of corporate bonds and equities.

2.3 Integrated Asset-Liability Approach

- The approach, integrating the liability portfolio with the asset portfolio, requires a formal method for selecting liabilities and for linking the asset performance with changes in the liability values.
  - **The previous two approaches** are most appropriate when asset allocation decisions are made after, and relatively independently of, decisions regarding the portfolio of liabilities.
  - However, the **integrated asset-liability approach** integrates and jointly optimizes asset and liability decisions.
- This approach can be implemented in a factor-based model, linking the assets and liabilities to the underlying driving factors.
- It has the potential to improve the institution's overall surplus.
- The capital required for this approach is often determined by reference to the output of integrated asset–liability systems in banks and property/casualty insurance and re-insurance companies.

Comparing the approaches

- **Surplus optimization and the hedging/return-seeking portfolio**
  - The **surplus optimization approach** links assets and the present value of liabilities through a correlation coefficient. The two-portfolio model does not require this input.
  - Implementation of the **basic two-portfolio approach** depends on having an overfunded plan. A **variant of the two-portfolio approach** might be applied, however.
  - **Surplus optimization** does not require an overfunded status. Both approaches address the present value of liabilities, but in different ways.

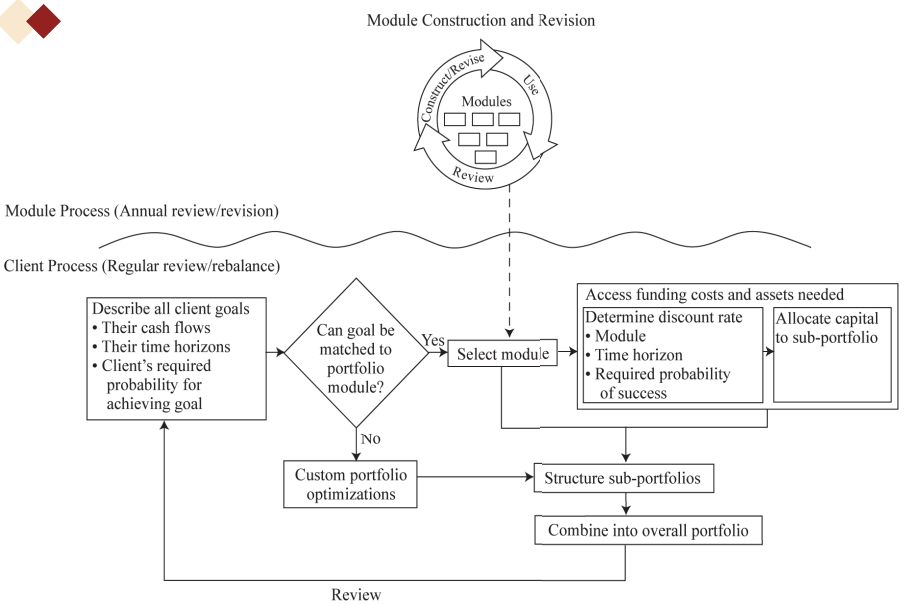
Surplus Optimization	Hedging/Return-Seeking Portfolios	Integrated Asset–Liability Portfolios
Simplicity	Simplicity	Increased complexity
Linear correlation	Linear or non-linear correlation	Linear or non-linear correlation
All levels of risk	Conservative level of risk	All levels of risk
Any funded ratio	Positive funded ratio for basic approach	Any funded ratio
Single period	Single period	Multiple periods

Framework

1. Developing asset-only asset allocations
2. Developing liability-relative asset allocation
3. Developing goals-based asset allocations
4. Heuristics and other approaches
5. Risk budgeting and Risk Party

3. Goals-Based Asset Allocations

- **Goals-based asset allocation applies best to individuals who have multiple goals, time horizons, and urgency levels.**
- **The Goals-Based Asset Allocation Process**
  - Describing Client Goals:
    - ✓ list all known 'needs' and 'wants'
    - ✓ Classify them in order of importance
    - ✓ Classify them as duration
  - Constructing Sub-Portfolios or Select Old Sub-Portfolio
  - The Overall Portfolio
  - Revisiting the Module Process in Detail
  - Periodically Revisiting the Overall Asset Allocation



Goals-Based - Constructing Sub-Portfolios

- **Allocate capital to sub-portfolios**
  - According to each client goal, **pick the highest probability**- and horizon-adjusted discount rates to discount the expected cash flows, and then obtain the **lowest initially required capital** for each goal.
- **Excess capital**
  - Think of additional goals
  - Revisit their current goals
    - ✓ Bring the timing of payments forward
    - ✓ Raise their probability of success
  - " Capital preservation "

Example

- A client express a very strong desire to fund his children's college education expenses, which have an estimated present value of $275,000. The client have two teenage children who will soon begin college. The client also plans to fund an endowment at their alma mater in 20 years, which has an estimated present value of $500,000. The client tells his adviser he wants a high probability of success funding the endowment. The adviser recommends the client to follow a goals-based approach to asset allocation and offers three possible portfolios to consider. Selected data on the three portfolios are presented in the exhibit below.

	Cash	Fixed Income	Global Equities	Diversifying Strategies
Portfolio 1	35%	55%	10%	0%
Portfolio 2	10%	15%	65%	10%
Portfolio 3	10%	30%	40%	20%

Example

- Based on the exhibit, which portfolio *best* meets the client's education goal for their children?
  A. Portfolio 1
  B. Portfolio 2
  C. Portfolio 3

- **Correct Answer: A**
  Portfolio 1 best meets the Laws' education goal for their children. The estimated present value of the Laws' expected education expense is $275,000. Given that the children will be starting college soon, and the Laws have a very strong desire to achieve this goal, Portfolio 1, which stresses liquidity and stability, is most appropriate to meet the Laws' short-term education goal.

Example

- Based on the exhibit, which portfolio *best* meets the client's goal to fund an endowment for their alma mater?
  A. Portfolio 1
  B. Portfolio 2
  C. Portfolio 3

- **Correct Answer: B**
  Portfolio 2 best meets the Laws' goal to fund an endowment for their alma mater in 20 years. In present value terms, the gift is valued at $500,000, with the Laws desiring a high probability of achieving this goal. Although slightly more conservative than the 75/25 global equity/bond mix, Portfolio 2 has a greater growth emphasis compared with Portfolios 1 and 3. Therefore, Portfolio 2 is best for funding the endowment at their alma mater given the goal's long-term horizon and the Laws' desire for a high probability of achieving it.

Example: 2018 Q9-C

- Sarzi also advises James and Karen Rozeer, a married couple who recently retired with total assets of USD 10 million. The Rozeers have two goals they wish to achieve during their retirement:
- **Goal 1:** The Rozeers wish to have an 85% chance of transferring USD 7.5 million to their children in 10 years.
- **Goal 2:** The Rozeers wish to have a 75% chance of being able to donate USD 15 million to a charitable organization in 25 years.
- Sarzi recommends implementing a goals-based approach to construct a portfolio. He develops a set of sub-portfolio modules, which are presented in Exhibit. Sarzi suggests investing any excess capital in Module A.

Example: 2018 Q9-C

"Highest Probability-and Horizon-Adjusted Return" Sub-Portfolio Modules Under Different Horizon and Probability Scenarios

	Module A	Module B	Module C
Portfolio Characteristics			
Expected return	6.1%	7.5%	8.3%
Expected volatility	5.9%	7.9%	10.1%
Annualized Minimum Expectation Returns			
Time Horizon (years)		10	
Required Success			
85%	4.2%	5.0%	4.9%
75%	4.8%	5.8%	6.1%
Time Horizon (years)		25	
Required Success			
85%	4.9%	5.9%	6.2%
75%	5.3%	6.4%	6.9%

Example: 2018 Q9-C

- **Construct** the overall goals-based asset allocation for the Rozeers given their two goals and Sarzi's suggestion for investing any excess capital. **Show** your calculations.
  - Note: The answer should be the **percentage of total assets** to be invested in each module.
- **Correct Answer:**
  - **Goal 1** has a time horizon of 10 years and a required probability of success of 85%. As a result, **Module B should be chosen because its 5.0% expected return is higher than the expected returns of all the other modules.** The present value of Goal 1, discounted using the 5.0% expected return, is calculated as:
    - ✓ N = 10, FV = –USD 7,500,000, I/Y = 5.0%; PV = USD 4,604,349 (or USD 4.60 million)
    - ✓ So, approximately **46.0%** of the total assets of USD 10 million (= USD 4.60 million / USD 10.00 million) should be allocated to Module B.

Example: 2018 Q9-C

- **Correct Answer: (con't)**
  - **For Goal 2**, which has a time horizon of 25 years and a required probability of success of 75%, **Module C should be chosen because its 6.9% expected return is higher than the expected returns of all the other modules**. The present value of Goal 2, discounted using the 6.9% expected return, is calculated as:
    - ✓ N = 25, FV = –USD 15,000,000, I/Y = 6.9%; PV = USD 2,829,102 (or USD 2.83 million)
    - ✓ So, approximately **28.3% of the total assets** of USD 10 million (= USD 2.83 million / USD 10.00 million) should be allocated to Module C.
  - Finally, the **surplus** of USD 2,566,549 (= USD 10,000,000 – USD 4,604,349 – USD 2,829,102), representing **25.7%** (= USD 2.57 million / USD 10.00 million), should be **invested in Module A** following Sarzi's suggestion.

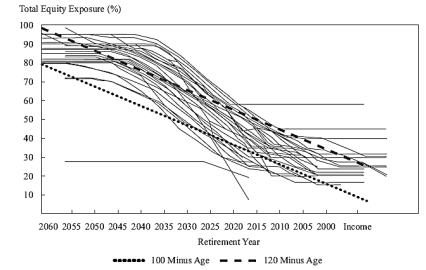
Framework

1. Developing asset-only asset allocations
2. Developing liability-relative asset allocation
3. Developing goals-based asset allocations
4. Heuristics and other approaches
5. Risk budgeting and Risk Party

4. Heuristic and Other Approaches

- **"120 minus your age" rule.**
  - **120 – Age = Percentage allocated to stocks**, which leads directly to an age-based stock versus fixed income split.
  - Although we are aware of no theoretic basis for this heuristic—or its older and newer cousins, "100 minus your age" and "125 minus your age," respectively - it results in a linear decrease in equity exposure that seems to fit the general equity glide paths associated with target-date funds, including those that are based on a total balance sheet approach that includes human capital.

Exhibit 44 Target-Date Funds and Age Heuristics (as of January 2016)



Heuristic and Other Approaches

- **60/40 stock/bond heuristic.**
  - An asset allocation consisting of **60% equities** and **40% fixed income**.
  - Equity allocation: supplying a long-term growth foundation; fixed-income allocation: risk reduction benefits
  - There is some evidence that the global financial asset market portfolio is close to this prototypical 60/40 split.
- **1/N rule**
  - In empirical studies comparing approaches, however, the 1/N rule has been found to perform considerably better, based on Sharpe ratios and certainty equivalents, than theory might suggest. One possible explanation is that the 1/N rule sidesteps problems caused by optimizing when there is estimation error in inputs.

Heuristic and Other Approaches

- **Endowment model (Yale model)**
  - High allocations to **non-traditional assets**
  - Seeks to **earn illiquidity premiums**
  - A commitment to active management
  - Endowments with long time horizons are well positioned to capture.

Exhibit 46 Yale University Endowment Asset Allocation as of June 2014

	Yale University	US Educational Institution Mean
Absolute return	17.4%	23.3%
Domestic equity	3.9	19.3
Fixed income	4.9	9.3
Foreign equity	11.5	22.0
Natural resources	8.2	8.5
Private equity	33.0	10.0
Real estate	17.6	4.2
Cash	3.5	3.5

Source: Yale University (2014, p. 13).

Framework

1. Developing asset-only asset allocations
2. Developing liability-relative asset allocation
3. Developing goals-based asset allocations
4. Heuristics and other approaches
5. Risk budgeting and Risk Party

5.1 Risk Budgeting

- **A risk budget** is simply a particular allocation of portfolio risk. The **goal** of risk budgeting is to maximize return per unit of risk—whether overall market risk or active risk.
- The **risk budgeting process** is the process of finding an optimal risk budget.
  - The **marginal contribution to total risk (MCTR)** identifies the rate at which risk would change with a small (or marginal) change in the current weights.

$$MCTR_i = \beta_i \times \sigma_p$$

  - The **absolute contribution to total risk (ACTR)** for an asset class measures how much it contributes to portfolio return volatility.

$$ACTR_i = w_i \times MCTR_i = w_i \times \beta_i \times \sigma_p$$

  - Excess return=expected return − risk-free rate
    - ✓ Sometimes, it is based on reverse-optimized returns.

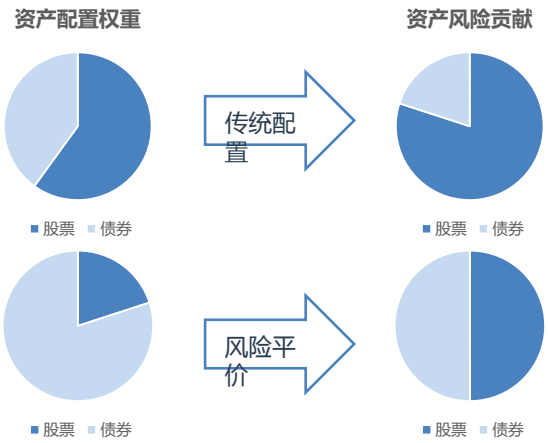
Risk Budgeting

- An asset allocation is optimal when the ratio of excess return (over the risk-free rate) to MCTR is the **same for all assets** and matches the Sharpe ratio of the tangency portfolio.
  - ✓ **Ratio of excess return to MCTR=(Expected return – Risk-free rate)/MCTR**

- The **objective of risk budgeting** in asset allocation is to use risk efficiently in the pursuit of return. A risk budget specifies the total amount of risk and how much of that risk should be budgeted for each allocation.
- **A risk budget is optimal when the ratio of excess return to marginal contribution to total risk is the same for all assets in the portfolio.**

5.2 Risk Parity

- A **risk parity asset allocation** is based on the notion that each asset (asset class or risk factor) should contribute equally to the total risk of the portfolio for a portfolio to be well **diversified**.



Risk Parity

- **Risk parity**
  - **Risk parity portfolio**
    - ✓ A risk parity asset allocation is based on the notion that each asset (asset class or risk factor) should contribute equally to the total risk of the portfolio for a portfolio to be **well diversified**.

$$ACTR = w_i\beta_i\sigma_p = \frac{1}{n}\sigma_p \qquad w_i \times Cov(r_i, r_p) = \frac{1}{n}\sigma_p^2$$

  - **Construct the overall portfolio**
    - ✓ Deriving a risk parity–based asset allocation (risk parity portfolio)
    - ✓ Borrow or to lend so that the overall portfolio corresponds to the investor's risk appetite.

Risk Parity

- In this case, each asset class contributed 0.8%, resulting in an asset allocation with a total standard deviation of 6.41%. In this example, 5/8 of total risk comes from equity asset classes and 3/8 comes from fixed-income asset classes.

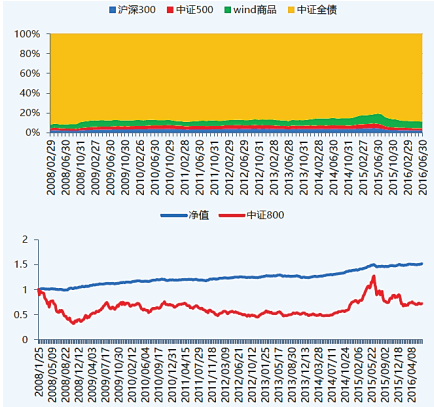
Asset Class	Weight	Marginal Contribution to Total Risk (MCTR)	ACTR	Percentage Contribution to Total Standard Deviation	Reverse-Optimized Total Returns
US large-cap equities	7.7%	10.43%	0.80%	12.50%	6.47%
US mid-cap equities	6.1	13.03	0.80	12.50	7.33
US small-cap equities	5.9	13.61	0.80	12.50	7.52
Non-US developed market equities	5.6	14.38	0.80	12.50	7.78
Emerging market equities	4.5	17.74	0.80	12.50	8.89
Non-US bonds	15.5	5.17	0.80	12.50	4.72
US TIPS	23.9	3.36	0.80	12.50	4.12
US bonds	30.8	2.60	0.80	12.50	3.86
Total	100.0%		6.41%	100.00%	5.13%

Risk Parity

- **Risk parity**
  - **Advantage**
    - ✓ The sources of risk are **diversified** (asset classes)
    - ✓ Back tests of levered risk parity portfolios have produced promising results
  - **Disadvantage**
    - ✓ It ignores expected returns
    - ✓ The contribution to risk is highly dependent on the formation of the opportunity set (fixed-income vs equity)
    - ✓ Back tests argue that they suffer from look-back bias
    - ✓ Dependent on the ability to use extremely large amounts of leverage at low borrow rates (which may not have been feasible)

Risk Parity

- **Risk Parity**



指数表现	多资产风险平价
年化收益率	5.08%
年化波动率	2.98%
夏普比率	1.03
最大回撤	4.06%
单次最大周换手	3.14%
平均周换手率	0.17%

Example

1. **Consider two asset classes, A and B. Asset class A has two times the weight of B in the portfolio. Under what condition would B have a larger ACTR than A?**
   - Because $ACTR_i$ = (Weight$_i$)(Beta with respect to portfolio)$_i$(Portfolio return volatility), the **beta of B would have to be more than twice as large as the beta of A** for B to contribute more to portfolio risk than A.
2. **When is an asset allocation optimal from a risk-budgeting perspective?**
   - An asset allocation is optimal when the **ratio of excess return (over the risk-free rate) to MCTR is the same** for all assets.

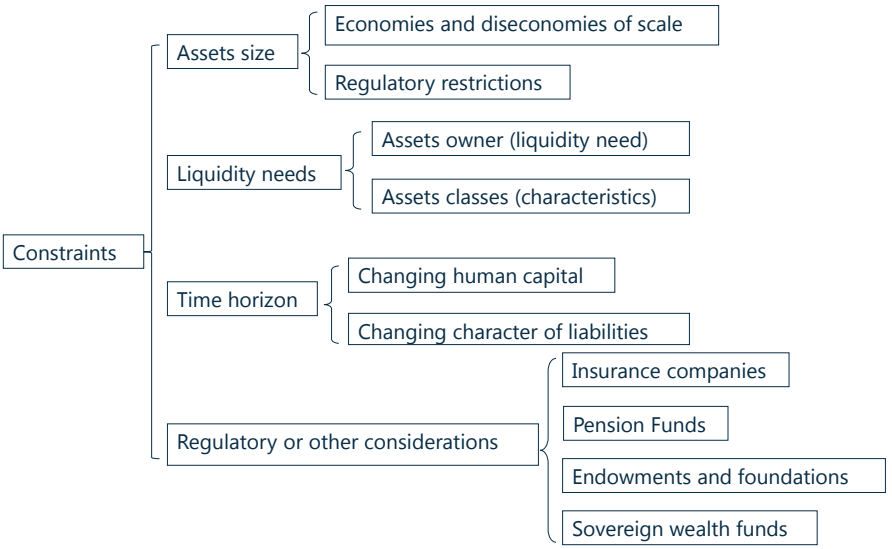
Reading 7

Asset Allocation with Real-World Constraints

Framework

1. Constraints on asset allocation.
2. Tax considerations in asset allocation.
3. Revisions to asset allocation.
4. Short-term shifts in asset allocation.
5. Behavioral biases and the methods of overcome them.

1. Constraints in Asset Allocation



1.1 Assets Size

- **Economies and diseconomies of scale**
  - The **disadvantages** subject to **large assets** are:
    - ✓ The **illiquidity** occurred when invest in small-cap stocks, either buy or sell;
    - ✓ **Invest in small-cap stock** will cause the market **wildly fluctuate**;
    - ✓ Capital inflow may cause active investment managers to pursue **ideas outside of their core investment thesis**;
    - ✓ **Organizational hierarchies** may slow down decision making and reduce incentives.
  - The **advantages** subject to **large assets** are:
    - ✓ Have sufficient size to build a **diversified portfolio** of investment strategies.

Assets Size

- **Economies and diseconomies of scale**
  - The **disadvantages** subject to **small assets** are:
    - ✓ **Insufficient amount to meet the minimum requirement** for some investments;
    - ✓ **Lower governance capacity-sophistication and manpower resource** - to develop the required knowledge base for complex asset classes and investment vehicles;
    - ✓ **Higher internal management cost;**
    - ✓ Many capital markets impose local legislation, **restricting investment in some assets with a given level of capital**;
    - ✓ **Too small to diversify** across the range of asset classes.

1.2 Liquidity

- **Different owners would have different liquidity needs.**
  - **Banks** typically have **greater liquidity needs** to meet their daily operations.
  - The same bank may have another **designated investment pool** one level removed from operating assets. This pool is able to handle some **illiquidity assets**.
  - **Long-term investors** can generally exploit **illiquidity premiums**.

Liquidity

- **Liquidity needs should be considered dynamically.**
  - A **university** must consider its prospects for future enrollments and the extent to which it relies on tuition to meet operating needs.
  - A **foundation** whose mission supports medical research in a field in which a break-through appears imminent may desire a higher level of liquidity to fund critical projects than would a foundation that supports ongoing community efforts.
  - An **insurance company** whose business is **predominantly life** or auto insurance, where losses are actuarially predictable, can absorb more liquidity risk than a **property/casualty** reinsurer whose losses are subject to unpredictable events, such as natural disasters.
  - **A family with several children nearing college-age** will have higher liquidity needs than a couple of the same age and circumstances with no children.

1.3 Time Horizon

- **Changing human capital**
  - When asset allocation considers such extended portfolio assets as human capital, the optimal allocation of financial capital can change through time.
- **Character of liabilities**
  - The changing character of liabilities through time will also affect the asset allocation aligned to fund those liabilities.
    - ✓ **For a firm**, the term structure of liabilities changes due to time lapses, new employments and resignations.
    - ✓ **For a individual investor**, he/she may set several goals when he was young. Each goal reflects a liabilities. With the change of time, the goal may change as well.

1.4 Regulatory and Other Considerations

- **Insurance Companies**
  - Insurers are most often highly focused on **matching assets to the projected**, probabilistic cash flows of the risks they are underwriting.
  - Some of the key considerations for insurance companies are **risk-based capital measures**, yield, liquidity, the potential for forced liquidation of assets to fund negative claims development, and credit ratings.
  - Allocations to certain **asset classes** are often constrained by a regulator.
- **Pension Funds**
  - Pension fund asset allocation decisions may be constrained by regulation and influenced by tax rules.
    - ✓ Some countries regulate **maximum or minimum percentages in certain asset classes**.
  - Pension funds are also subject to a wide array of funding, accounting, **reporting**, and tax constraints.

Regulatory and Other Considerations

- **Endowments and Foundations**
  - Endowments and foundations are often established with the expectation that they will exist in perpetuity and thus can invest with a **long investment horizon**.
  - Two categories of externally imposed constraints may influence the asset allocation decisions of an endowment or foundation.
    - ✓ **Tax incentives**: many countries provide tax benefits tied to **certain minimum spending requirements**.
    - ✓ **Credit considerations**: external factors may restrict the level of risk-taking in the portfolio.

Regulatory and Other Considerations

- **Sovereign Wealth Funds(SWFs)**
  - In addition to the broad constraints of asset size, liquidity, time horizon, and regulations, there may be cultural or religious factors which also **constrain the asset allocation choices**.
- **Environmental, social, and governance (ESG) considerations**
  - Becoming increasingly important to institutional and individual investors alike.

2.1 Asset Allocation for the Taxable Investor

- **After-Tax Portfolio Optimization**
  - The return will be affected by the tax:
    - ✓ $\mathbf{r_{at} = r_{pt}(1 - t)}$
      - r_{at} = the expected after-tax return
      - r_{pt} = the expected pre-tax (gross) return
      - t = the expected tax rate
  - If the expected return composed by different integral:
    - ✓ $\mathbf{r_{at} = p_d r_{pt}(1 - t_d) + p_a r_{pt}(1 - t_{cg})}$
      - p_d = the proportion of r_{pt} attributed to dividend income
      - p_a = the proportion of r_{pt} attributed to price appreciation
      - t_d = the dividend tax rate
      - t_{cg} = the capital gains tax rate

2.2 Asset Allocation for the Taxable Investor

- **After-Tax Portfolio Optimization**
  - As the tax and tax loss carry forward exist, the expected volatility of will be reduced as well.
    - ✓ $\sigma_{at} = \sigma_{pt}(1 - t)$
      - σ_{at} = the expected after-tax standard deviation
      - σ_{pt} = the expected pre-tax standard deviation
  - **The correlations of asset classes will remain** after the charge of tax.
  - As the expected return and after-tax standard deviation differ from the original data, the **optimal portfolio would change** as well.

2.3 Asset Allocation for the Taxable Investor

- **Taxes and Portfolio Rebalancing**
  - **The rebalancing ranges for a taxable portfolio can be wider than those of a tax-exempt portfolio with a similar risk profile:**
    - ✓ $R_{at} = R_{pt}/(1 - t)$
    - ✓ Where

      R_{at}=the after-tax rebalancing range

      R_{pt}= the pre-tax rebalancing range

Example

- Consider a portfolio with a 50% allocation to equity, where equity returns are subject to a 25% tax rate. A tax-exempt investor may establish a target allocation to equities of 50%, with an acceptable range of 40% to 60% (50% plus or minus 10%). What the range should be for a taxable investor who would like to achieve the same target equity allocation.

- **Correct answer:**
  - $10\% \div (1\text{-}25\%) = 13.3\%$

    $50\% \pm 13.3\%$
  - A taxable investor with the same target equity allocation can achieve a similar risk constraint with a range of 37% to 63% (50% plus or minus 13%).

2.5 Asset Allocation for the Taxable Investor

- Aggregating assets across accounts with differing tax treatment requires modifying the asset value inputs to the portfolio optimization.
- **The after-tax value of assets in a tax-deferred account is defined by**
  - $v_{at} = v_{pt}(1 - t_i)$

  where

  v_{at} = the after-tax value of assets

  v_{pt} = the pre-tax market value of assets

  t_i = the expected income tax rate upon distribution

3. Revising the Strategic Asset Allocation

- All asset owners should **affirm annually** that the asset allocation remains appropriate given their needs and circumstances.
  - **A change in goals**
    - ✓ Changes in business conditions such as organization supporting;
    - ✓ A change in the investor's personal circumstances.
  - **A change in constraints**
    - ✓ Changes in the expected payments from the fund;
    - ✓ A significant cash inflow or unanticipated expenditure;
    - ✓ Changes in regulations governing donations or contributions;
    - ✓ Changes in time horizon resulting from the adoption of a lump sum distribution option at retirement;
    - ✓ Changes in asset size as a result of the merging of pension plans.

Revising the Strategic Asset Allocation

- **A change in beliefs**
  - ✓ Investment beliefs are a set of guiding principles that govern the asset owner's investment activities.
    - ◆ A material change in the outlook for one or more of the asset classes may heavily influence the asset allocation outcome.
    - ◆ As new advisers or members join the Investment Committee, they bring their own beliefs and biases regarding certain investment activities.

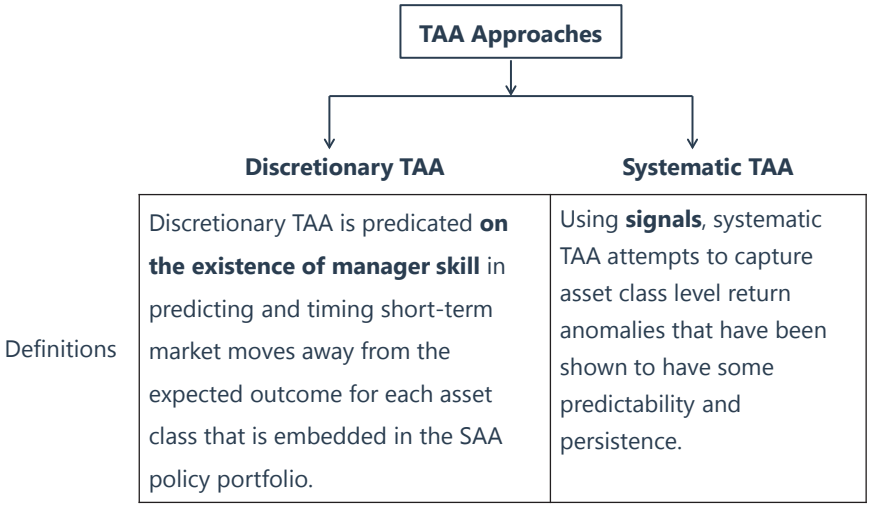
4. Short-Term Shifts in Asset Allocation

- **Tactical asset allocation (TAA) allows short-term deviations from SAA targets.**
  - Generating alpha through TAA decisions is dependent on successful market or factor timing rather than security selection.
- **Most common ways to evaluate TAA decisions**
  - A comparison of the Sharpe ratio realized under the TAA relative to the Sharpe ratio that would have been realized under the SAA;
  - Evaluating the information ratio;
  - The t-statistic of the average excess return of the TAA portfolio relative to the SAA portfolio;
  - Plotting the realized return and risk of the TAA portfolio versus the realized return and risk of portfolios along the SAA's efficient frontier.
    - ✓ (This approach is particularly useful in assessing the risk-adjusted TAA return.)

121-130

Short-Term Shifts in Asset Allocation

- **Two major approaches to TAA**



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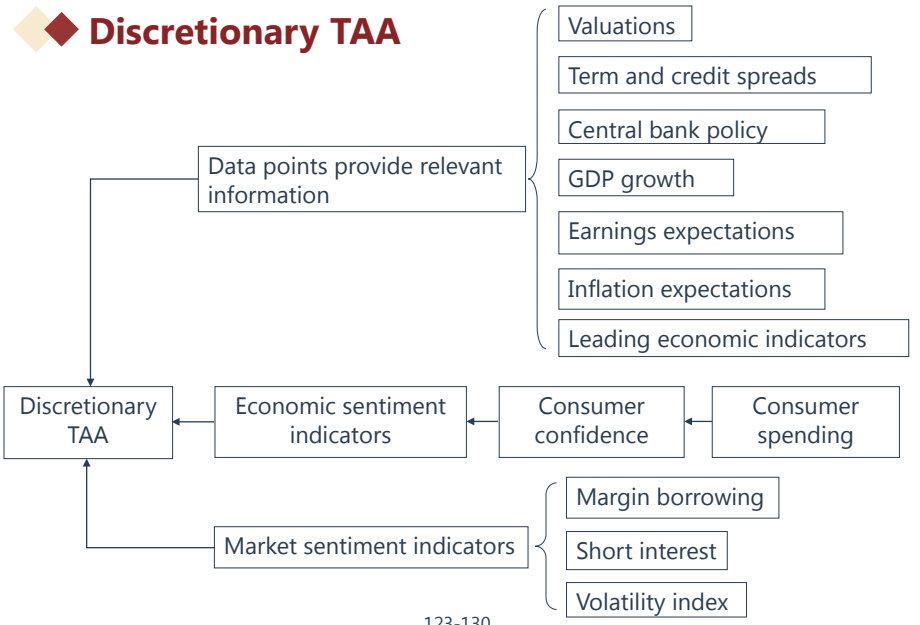
Discretionary TAA



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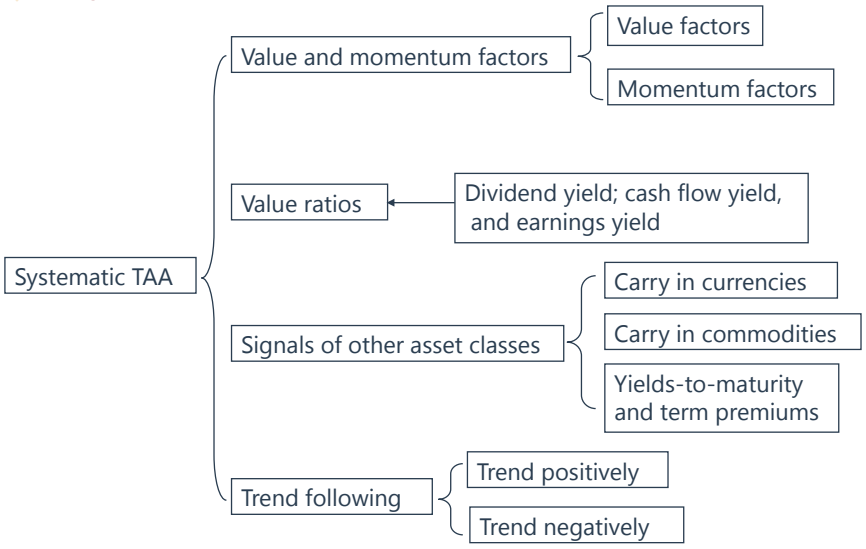
Systematic TAA



5. Dealing with Behavioral Biases

- **Identify Anomalies**
  - **Loss-aversion bias** is an emotional bias in which people tend to strongly prefer avoiding losses as opposed to achieving gains.
  - **The illusion of control** is a cognitive bias - the tendency to overestimate one's ability to control events.
  - **Mental accounting** is an information - processing bias in which people treat one sum of money differently from another sum based solely on the mental account the money is assigned to.

Dealing with Behavioral Biases

- **Identify Anomalies**
  - **Representative**, or **recency**, bias is the tendency to overweight the importance of the most recent observations and information relative to a longer-dated or more comprehensive set of long-term observations and information.
  - **Framing bias** is an information-processing bias in which a person may answer a question differently based solely on the way in which it is asked.
  - **Availability bias** is an information-processing bias in which people take a mental shortcut when estimating the probability of an outcome based on how easily the outcome comes to mind.

Dealing with Behavioral Biases

- **How to deal with behavior biases**
  - **Loss-aversion**: In goals-based investing, loss-aversion bias can be mitigated by framing risk in terms of shortfall probability or by funding high-priority goals with low-risk assets.
  - **Illusion of Control**: The illusion of control can be mitigated by using the global market portfolio as the starting point in developing the asset allocation.
  - **Mental Accounting**: Goals-based investing incorporates mental accounting directly into the asset allocation solution. Each goal is aligned with a discrete sub-portfolio, and the investor can specify the acceptable level of risk for each goal. Provided each of the sub-portfolios lies along the same efficient frontier, the sum of the sub-portfolios will also be efficient.

Dealing with Behavioral Biases

- **How to deal with behavior biases**
  - **Representative Bias**: The strongest defenses are an objective asset allocation process and a strong governance framework.
  - **Framing Bias**: The framing effect can be mitigated by presenting the possible asset allocation choices with multiple perspectives on the risk/reward trade-off.
  - **Availability Bias**: Familiarity bias (a bias stems from availability bias) can be mitigated by using the global market portfolio as the starting point in developing the asset allocation, where deviations from this baseline portfolio must be thoughtfully considered and rigorously vetted.

Dealing with Behavioral Biases

- **To make sure the asset allocation decision is as objective as possible, managers should:**
  - Employ a formal asset allocation process using the global market portfolio;
  - Employ a strong governance structure;
  - Bring a diverse set of views to the deliberation process;
  - Have a clear stated mission-a common goal-and a commitment from committee members and other stakeholders.

It's not an end but just the beginning.

The failures and reverses which await men - and one after another sadden the brow of youth - add a dignity to the prospect of human life, which no Arcadian success would do. -- Henry David Thoreau.

尽管失败和挫折等待着人们，一次次地夺走青春的容颜，但却给人生的前景增添了一份尊严，这是任何顺利的成功都不能做到的。

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.202205CFA三级长线无忧班）
    - ✓ 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
  - 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）。