**Principles of Asset Allocation**

**1. INTRODUCTION**

Two separate decisions for a diversified multi-asset class portfolio includes:
- Asset allocation decision – translating the client’s goals & constraints into an appropriate portfolio.
- Implementation decision – determining specific investments

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**2. DEVELOPING ASSET-ONLY ASSET ALLOCATION**

- **2.1 MVO Overview**
  - MVO requires 3 inputs: i) returns, ii) risks and iii) related assets’ pairwise correlations.
  - Risk-adjusted exp. return = \( U_m = E(R_m) - 0.005 \lambda \sigma_m^2 \)
  - Common Constraints are ‘budget constraint’ & ‘no negative or short position’.
  - To estimate risk aversion, determine investor’s risk preference & risk capacity
  - ‘Global min. variance portfolio’, has the lowest risk & is located at the far left of the efficient frontier.
  - ‘Max. expected return portfolio’ is the portfolio at the far right of the frontier. If no constraints, the max. exp. return portfolio allocates 100% in the single asset with the highest expected return.
  - MVO is a single-period framework

- **2.2 Monte Carlo Simulation**
  - outcomes are sensitive to small \( \Delta \) in inputs.
  - highly concentrated asset classes.
  - focuses on the mean and variance of returns only.
  - may fail to properly diversify the sources of risk.
  - does not consider the economic exposures of liabilities.
  - not useful for multi-period objectives.
  - does not take into account trading/rebalancing costs and taxes.

- **2.3 Criticisms of MVO**
  - Including less liquid asset classes in the optimization is challenging as indexes fail to gauge aggregate performance of asset class: the characteristics of assets differ significantly because of idiosyncratic (co. specific) risk.
  - focusing on optimization to an opportunity set consisting of investment factors (fundamental or structural)

- **2.4 Addressing the Criticisms of MVO**

- **2.5 Allocating to Less Liquid Asset Classes**

- **2.6 Risk Budgeting**
  - finding optimal risk budget to maximize return per unit of risk.
  - Some key computations for risk budgeting:
    - Marginal contribution to risk (\( MCTR_i \)) = (Beta of Asset Class / relative to Portfolio) x (Portfolio S.D)
    - Absolute contribution to risk (\( ACTR_i \)) = Asset class weight \( i \) x MCTR
    - Portfolio S.D = Sum of \( ACTR = \sum_{i}^{n} ACTR_i \)
    - % contribution to total S.D = \( \frac{ACTR}{Portfolio \ S.D} \)
    - Ratio of excess return to MCTR = \( \frac{(Expected \ Return - R_i)}{MCTR} \)

- **2.7 Factor-Based Asset Allocation**

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\[ S.D = \text{standard deviation} \]
### 2.4.1 Reverse Optimization
- Technique for reverse engineering the expected returns implicit in a diversified portfolio.
- Works opposite to MVO.
- Inputs are: optimal asset allocation weights (derived from the optimization process), covariances & $\lambda$.
- Outputs are: expected returns.

### 2.4.2 Black-Litterman Model
- Combines investor's expected returns forecasts with reverse-optimized returns and makes MVO process more useful.

### 2.4.3 Adding Constraints beyond the Budget Constraints:
- To incorporate real-world constraints into the optimization process.
- To overcome MVO problems regarding input quality, input sensitivity, concentrated allocations.

### 2.4.4 Resampled MVO
- Combines MVO with Monte-Carlo simulation and addresses the issues of input uncertainty, estimation error, and diversification associated with traditional MVO.

### 2.4.5 Other Non-Normal Optimization Approaches:
- More sophisticated techniques are trying to overcome MVO challenges by incorporating non-normal return distribution & by using other risk measures such as value-at-risk etc.

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### 3. DEVELOPING LIABILITY-RELATIVE ASSET ALLOCATION

#### 3.1 Characterizing the Liabilities
- Fixed vs. contingent cash flows
- Legal vs. quasi-liabilities
- Duration and convexity of liability cash flows
- Value of liability relative to the size of the sponsoring organization
- Factors driving future liability cash flows (inflation, discount rate, economic changes, risk premium)
- Timings
- Considerations
- Regulations affecting liability cash flow calculations

#### 3.2 Approaches to Liability-relative Asset Allocation

##### 3.2.1 Surplus Optimization
- $U_{m}^{ALM} = E(R_{m}) - 0.005\sigma^2(R_{m})$
- Steps for surplus optimization:
  - Select asset classes & the time period
  - Estimate $E(R)$ & S.D
  - Add investor constraints.
  - Estimate the correlation matrix and volatilities for asset classes & liabilities.
  - Compute surplus efficient frontier
  - Select the desired portfolio mix

##### 3.2.2 Hedging/Return-Seeking Portfolio Approach
- Two-portfolio approach: hedging portfolio & surplus portfolio.
- Several variants of two-portfolio approach when there is no +ve surplus

##### 3.2.3 Integrated Asset-liability Approach:
- Jointly optimizes asset and liability decisions.
- Useful for banks, long-short hedge funds, insurance or reinsurance

- Liability cash flows typically count on multiple factors or uncertainties. The two primary factors are inflation & future economic conditions.

#### 3.3 Examining the Robustness of Asset Allocation Alternatives

- "What if" sensitivity analysis
- Scenario analysis
- Simulation analysis

#### 3.4 Factor-Modeling in Liability Relative Approaches:

<table>
<thead>
<tr>
<th>Surplus Optimization</th>
<th>Hedging/Return-Seeking Portfolio</th>
<th>Integrated Asset-Liability Portfolio</th>
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<tbody>
<tr>
<td>Simple, ext. of asset-only MVO</td>
<td>Simple, separating assets in two buckets</td>
<td>Complex</td>
</tr>
<tr>
<td>Linear correlation</td>
<td>Linear/non-linear correlation</td>
<td>Linear/non-linear correlation</td>
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<tr>
<td>All levels of risk,</td>
<td>Conservative level of</td>
<td>All levels of risk</td>
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<tr>
<td>Assumptions similar to Markowitz model.</td>
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<tr>
<td>Any funded ratio</td>
<td>+ve funded ratio for basic approach</td>
<td>Any funded ratio</td>
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<tr>
<td>Single period</td>
<td>Single Period</td>
<td>Multiple Period</td>
</tr>
</tbody>
</table>
4. DEVELOPING GOALS-BASED ASSET

4.1 The Goals-Based Asset Allocation Process

Two essential parts of this process are:
1. creating portfolio module
2. matching each goal with suitable sub-portfolios.
- Advisors usually apply pre-established models that best serve the purpose.
- Different modules represent different features e.g. implied risk/return tradeoffs, liquidity concerns, eligibility of some asset-classes or strategies.

4.2 Describing Client Goals

Distinguish b/w cash flow based-goals (for which cash flows are defined) and labeled goals (for which investor is unclear about the need).

4.3 Constructing Sub-Portfolios

The overall asset allocation is aggregation of individual exposures

4.4 The Overall Portfolio

- Because of constraints, the resultant frontier is not therefore, following concerns are crucial.
  i. Liquidity concerns
  ii. Non-normal return distribution
  iii. Include drawdown controls
- Regularly revise: modules & investor constraints

4.5 Revisiting the Module

4.6 Periodically Revisiting the Overall Asset Allocation Process in Detail:

• Time horizons are generally rolling concepts
• Portfolios, typically, outperform the discount rate and resultant excessive assets need rebalancing

4.7 Issues related to the Goals-Based Asset Allocation

Managing more than one policy for each client, Handling portfolios on day-to-day Satisfying regulatory requirements of treating all clients equivalently

5. HEURISTICS AND OTHER APPROACHES TO ASSET ALLOCATION

Some other offhand techniques for asset allocation
- 120 minus your age rule
  120 minus age = equity allocation
- 60/40 stock/bond heuristic
- Endowment Model or Yale model
  allocates large portion to non-traditional investments (private equity, real-estate)
- Risk Parity (each asset class should contribute evenly to the overall portfolio risk). Mathematically:
  \[ w_i \times Cov(r_i, r_p) = \frac{1}{n} \sigma^2 \]
- The 1/N rule involves allocating equal % to each of (N) asset classes.

6. PORTFOLIO REBALANCING IN PRACTICE

Factors & their relation with corridor width | Effect on optimal width of corridor (all else equal)
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Transaction costs +ve | ↑ transaction cost, wider the corridor
Risk tolerance +ve | ↑ risk tolerance, wider the corridor
Correlation with the rest of the portfolio +ve | ↑ correlation, wider the corridor
Volatility of the rest of the portfolio -ve | ↑ volatility, narrower the corridor