608
RISK BUDGETING AND INVESTMENT MANAGEMENT

Committee on Investments / Investment Advisory Committee
August 24, 2006
AGENDA

◆ “Measuring” Risk
◆ Active Risk
◆ “Budgeting” Risk
◆ UCRP Risk Budgets
◆ How Risk Budgets are used
◆ Appendix 1: A Detailed Example
◆ Appendix 2: How Risk Budgets are Determined
OVERVIEW

◆ Risk management is a critical part of investment management at UC
◆ It is part of managing each asset class and the total fund
◆ The first step is identifying and quantifying various risks in the portfolios
◆ The second step is to allocate, or budget risk to achieve the best expected return
Most investors “feel” that higher risk – potential for loss – should be compensated by higher returns.

Higher risk is typically correlated with higher volatility of returns.

Volatility (std. deviation) is a proxy for risk, not a measure of risk.

It is a good approximation of loss potential for traditional portfolios (most of the assets).
“MEASURING” RISK

◆ For traditional portfolios, volatility tells us the likely range of outcomes, e.g.,

◆ U.S. Stocks, 1946-2006, had a range of ±16.9% around their average annual return of 12.8%

◆ In any 2 out of 3 years, we expect the return on stocks to be between -4.2% and +29.7%
  
  ■ Actually occurred 62% of those years
Bond returns are less volatile, but have lower expected return (shown on the same scale as equity).

Average = 1.0% / Month, Std. Dev = 4.1% / Month
“MEASURING” RISK

◆ For non-traditional assets, we use other risk proxies which focus on potential for loss (“down-side” volatility)
  
  ■ “Value-at-Risk” measures expected loss given extreme events
  
  ■ It is used to allocate capital to strategies with option-like returns

◆ Risk measures are not forecasts of returns
“Active risk” (aka, Tracking Error) is defined as the volatility of active returns (= portfolio less benchmark return)

Different than “total risk” (see above)

It is a measure of how “different” the portfolio is from the benchmark

It gives an indication of the likely range of active returns around the benchmark
Active risk results from any difference between a portfolio and benchmark, e.g.,

Over/(under) weight securities, industries, sectors, countries, regions, currencies, styles, capitalization size, etc.

At the total fund level, it will result from over/(under) weighting an asset class relative to policy weights.
LINKING RISK AND RETURN

◆ Managers take active risk – have exposures different than the benchmark – to earn active returns

◆ All else equal, expected active return is a function of active risk (the size of the differences)

◆ Risk (differences from benchmark) is thus the “input” to the investment process, and is carefully managed
BUDGETING RISK

◆ We manage active risk by setting a budget for risk (the investment plan)
◆ Similar to any organization which sets a budget for expenses
◆ Then we measure risk and compare realized risk to our budgets (plan)
◆ We explain variance between plan and actual, and recommend changes if needed
The active risk budget for the UCRP is 3% annualized tracking error.

- In every 2 of 3 years, the expected active return will be within +/-3% of the performance benchmark.

This level of active risk is:

- Consistent with historical volatility of UCRP.
- Consistent with other pension plans.
UCRP ACTIVE RISK BUDGET

◆ This level of active risk is:
  ■ Consistent with reasonable budgets for the risk of the asset classes which comprise the fund
  ■ Consistent with the investment objectives of the fund (modest value added)
  ■ Sufficient to allow flexibility in allocating risk to strategies with higher expected return

◆ Note, GEP active risk budget is higher, at 4.5%
This level of active risk adds a negligible amount of volatility to the total fund (that is, over benchmark volatility)

With benchmark volatility at 11%, an active risk budget of 3% results in portfolio volatility of 11.4%

Only 40 basis points additional volatility

Benchmark Risk = 11%

Active Risk = 3%

Portfolio Risk = 11.4%
UCRP monthly total returns, 1986-2006

UCRP total return volatility was 11.3% annually, or 3.3% monthly, over 20 year period.

NOTE DIFFERENT SCALES

UCRP monthly active returns, 1986-2006

UCRP active return volatility was 2.8% annually, or 0.8% monthly, over 20 year period.
### Asset Class

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Active Risk Budget</th>
<th>Realized Active Risk (1,4)</th>
<th>Forecast Active Risk (2,4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Equity - passive</td>
<td>0.20</td>
<td>0.04</td>
<td>0.26</td>
</tr>
<tr>
<td>US Equity - active</td>
<td>2.50</td>
<td>1.62</td>
<td>1.48</td>
</tr>
<tr>
<td>Non US Eq - passive</td>
<td>0.50</td>
<td>0.16</td>
<td>0.54</td>
</tr>
<tr>
<td>Non US Eq - active</td>
<td>3.00</td>
<td>1.27</td>
<td>1.59</td>
</tr>
<tr>
<td>EM Equity</td>
<td>4.00</td>
<td>2.05</td>
<td>4.14</td>
</tr>
<tr>
<td>US Fixed - LPF</td>
<td>1.50</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>US Fixed - LB Agg</td>
<td>1.00</td>
<td>0.24</td>
<td>0.23</td>
</tr>
<tr>
<td>High Yield</td>
<td>3.50</td>
<td>NA (6)</td>
<td>1.57</td>
</tr>
<tr>
<td>Non US Fixed</td>
<td>2.00</td>
<td>NA (6)</td>
<td>0.03</td>
</tr>
<tr>
<td>EM Debt</td>
<td>4.00</td>
<td>NA (6)</td>
<td>1.38</td>
</tr>
<tr>
<td>TIPS</td>
<td>0.25</td>
<td>0.16</td>
<td>0.02</td>
</tr>
<tr>
<td>Cash (5)</td>
<td>0.75</td>
<td>0.02</td>
<td>0.62</td>
</tr>
<tr>
<td>Private RE</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Private Eq</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Absolute Return (3)</td>
<td>NA</td>
<td>2.44</td>
<td>4.43</td>
</tr>
<tr>
<td>TOTAL UCRP</td>
<td>3.00</td>
<td>0.48</td>
<td>0.55</td>
</tr>
<tr>
<td>TOTAL GEP</td>
<td>4.50</td>
<td>0.59</td>
<td>1.16</td>
</tr>
</tbody>
</table>

NOTES (1) Realized Risk calculations based on most recent 12 months' returns, equally wtd, as of July 31, 2006  (2) Forecast Risk based on actual holdings and third-party risk models, as of June 30, 2006  (3) Values are for total, not active risk  (4) Value is higher of UCRP and GEP asset class composite  (5) Forecast active risk using benchmark similar to ML 1-3 Yr Treasury  (6) Only 6 months history

Note that both realized and forecast risk are lower than the risk budgets, which is partly due to low cross sectional market volatility.
When would a risk budget change?

- Overall risk tolerance of the Committee changes
- Opportunities in active strategies expand or contract
- Overall level of market volatility or cross sectional volatility changes
The innovation of risk management is a common framework and uniform metric to quantify all investment decisions.

Allowing us to trade-off risk in one area with risk in another.

If we have “used up” our risk budget, we must reduce risk in one or more strategies in order to take risk in another one.
EXAMPLE: ACTIVE EQUITY

◆ 50% of US Equity allocation is actively managed
  ■ Assume passive has zero active risk
◆ Is that the right amount for active?
◆ Depends on the risk level of the active portfolios
  ■ Enhanced, risk controlled active
    ◆ 3% tracking error → total has 1.5% TE
  ■ Traditional, concentrated active
    ◆ 10% tracking error → total has 5.0% TE
VALUE OF RISK BUDGETS

◆ Enable more efficient use of risk, by linking expected return to risk
  ▪ Better than traditional guidelines and constraints
◆ Aid in asset allocation and manager structure decisions
◆ Ensure risk is used intentionally and compensated adequately
◆ Quality control for the main input to the investment process
The essence of investment management is the management of risk, not the management of return.

—Benjamin Graham
APPENDIX 1: EXAMPLE OF RISK BUDGETING

Committee on Investments / Investment Advisory Committee
August 24, 2006
WHY RISK BUDGETING?

◆ Large institutional investors typically maintain a **passive** (core, low-cost) equity allocation
◆ What should be the **percentage** of passive vs. actively managed assets?
◆ Better question: what is **desired** amount of **active risk** in the fund?
◆ Assumes “amount of risk” can be **quantified**
Managing investments has always been about managing risk.

Traditionally done with inefficient guidelines and constraints:

- E.g., position and sector limits; limits on manager size, long only constraint; no derivatives; credit limits

These are all examples of risk proxies.

Why not manage the risk factors directly, and link risk to expected return?
WHY IS THIS INEFFICIENT?

- Constraints are proxies for risk; crude (but sometimes effective) risk controls
- They don’t account for actual contribution to risk of different positions
- Constraints don’t account for volatility, correlations, or hedges
- Constraints cannot be combined or traded off against each other
RISK BUDGETING APPROACH

◆ **Measure** risk using a uniform metric for all types of decisions
◆ **Set overall limits** on that metric
◆ **Flow-down** to underlying components or decisions
  - *Based on contribution of each component or decision to total risk*
◆ **Allows risk to be fungible**
  - *And for decision makers to shift risk exposures to capture expected returns*
### EXAMPLE: ACTIVE vs. PASSIVE

<table>
<thead>
<tr>
<th>CASE 1</th>
<th>CASE 2</th>
<th>CASE 3</th>
<th>CASE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp</td>
<td>Active Risk</td>
<td>Exp</td>
<td>Active Risk</td>
</tr>
<tr>
<td>Passive</td>
<td>66</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Enhanced</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Traditional Active</td>
<td>8.5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Traditional Active</td>
<td>8.5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Traditional Active</td>
<td>8.5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Traditional Active</td>
<td>8.5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>1.36</td>
<td>1.36</td>
</tr>
<tr>
<td>Information Ratio</td>
<td>1.00</td>
<td>1.44</td>
<td>1.59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weight</th>
<th>Contrib to Risk</th>
<th>Weight</th>
<th>Contrib to Risk</th>
<th>Weight</th>
<th>Contrib to Risk</th>
<th>Weight</th>
<th>Contrib to Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive</td>
<td>66</td>
<td>-</td>
<td>33</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Enhanced</td>
<td>0</td>
<td>-</td>
<td>33</td>
<td>5.56</td>
<td>46</td>
<td>10.27</td>
<td>60</td>
</tr>
<tr>
<td>Trad. Active</td>
<td>34</td>
<td>100.00</td>
<td>34</td>
<td>94.44</td>
<td>34</td>
<td>89.73</td>
<td>20</td>
</tr>
</tbody>
</table>

*Note in case 4, higher information ratio with less risk*

*Risk controlled, between Enhanced and Traditional*
EXAMPLE: ACTIVE vs. PASSIVE

Active Return vs. Active Risk

Note in case 4, higher information ratio with less risk

CASE 1  CASE 2  CASE 3  CASE 4
BASIC PRINCIPLE

◆ Allocate risk to decisions / sectors in proportion to expected returns

◆ Results in a more efficient use of risk
  ■ Suppose the ratio \( \frac{\text{return}}{\text{contrib. to risk}} \) for first view is greater than ratio for second view
  ■ Then we can increase size of first view relative to second view
  ■ And have a higher expected return per unit of risk ("information ratio")
STEPS IN RISK BUDGETING

- Determine **desired active return**
- Determine **achievable information ratio**
  - Based on *skill in manager / security selection and degree of diversification*
- Calculate aggregate **active risk budget**
  - *Active risk* = *Desired active return ÷ IR*
- Determine degree of **skill in each component** (e.g., asset class) of total fund
- Allocate active risk budget to each component
  - Based on *expected return, risk, and correlations among strategies*
SPECTRUM OF ACTIVE RISK

- Risk relative to benchmark ("active risk")
  depends on "active weight" of each security
  - Passive: Port. Wt = Bench. Wt
  - Enhanced 1: active wts < 5bp, wt > 0
  - Enhanced 2: active wts < 20bp, wt > 0
  - Enhanced 3: same as 2, wt may be < 0
  - Enhanced 4: active wts < 1%,
    active sector wts < 5%
    wt may be < 0
  - Traditional 1: active wts < 5%, wt > 0,
    active sector wts < 15%
  - Traditional 2: active wts < 10%, wt > 0
APPENDIX 2: HOW RISK BUDGETS ARE DETERMINED

Committee on Investments / Investment Advisory Committee
August 24, 2006
HOW RISK BUDGETS ARE DETERMINED

- **Total Risk [Total Fund only]**
  - Start with level of benchmark risk
  - This risk level is required to meet the return objectives of the fund, and is chosen by the Committee
  - Add active risk budget (assume it is uncorrelated with systematic risk)
  - Total risk may be within ± 20% of this value
HOW RISK BUDGETS ARE DETERMINED

Active Risk - Asset Class

- Consider \textit{realized volatility} and \textit{correlations} of managers in each asset class over several cycles.
- Consider \textit{expected (or actual) number of managers} in each asset class.
- Combine current (or potential) managers’ risks and correlations at current (or potential) weights.
- Risk budget of combination will be smaller than average manager risk.
Example: Active Risk – Non US Equity (Developed)

- Selected 11 managers with various levels of active risk
- Median tracking error* = xx%
- Median correlation* of active return = xx%
- Combined tracking error = xx%
- Allowing for periods of higher volatility and correlation: set budget at 3.0%

*based on last 36 months returns and analysis of holdings
Active Risk - Total Fund

- Consider *historical* volatility of UCRP
- Consider *median* volatility of large pension plans
- Combine risk budgets for each asset class at policy proportions
  - Assumes active risk is attached to each asset class exposure
- Add allowance for *misfit risk* of aggregate manager benchmark
Active Risk - Total Fund, contd.

- Add allowance for **tactical asset allocation** within approved ranges
- Resulting overall budget for UCRP is 3% annualized TE
- Active risk may be within ±1% of this value
- Risk budget can fluctuate based on **level of market**