REALIZED RETURN OPTIMIZATION

A NEW APPROACH TO LIABILITY FUNDING

by

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(This presentation was made while the author was Vice President and Manager of the Insurance Strategies Group at Drexel Burnham Lambert.)
The following pages outline the presentation made at the 24th Actuarial Research Conference. The articles listed below describe Realized Return Optimization and its applications in greater detail.


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A NEW APPROACH TO LIABILITY FUNDING

PRAKASH A. SHIMPI, ASA
VICE PRESIDENT
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AUGUST 25, 1989
TRADING CRITERIA

PICK UP YIELD AND MAINTAIN DURATION

i.e., Increase PERFORMANCE For The Same RISK

QUESTIONS:

1. Is Yield An Appropriate Measure Of Performance?

2. Can Duration Be Used To Measure Risk?

3. Are Trading Criteria Consistent With Liability Funding?
VALIDITY OF BOND YIELD COMPARISONS

VARIOUS DEFINITIONS:

1. Yield To Maturity
2. Yield To Call
3. Option-Adjusted Yield
4. Stable Rate Yield

COMPARISONS AFFECTED BY:

1. Different Maturities
2. Different Coupons
3. Different Credit Ratings
4. Implicit Reinvestment Assumptions
5. Liquidating Investments Before Maturity
**BOND YIELD VS. PORTFOLIO YIELD**

**YIELD** : Equates Present Value Of Cash Flow To Market Value

**Market Value Weighted Yield Of Bonds**

\[ \text{Market Value Weighted Yield Of Bonds} = \sum \frac{\text{Market Value Of Bond} \times \text{Yield Of Bond}}{\sum \text{Market Value Of Bond}} \]

\[ \neq \text{Portfolio Yield} \]

**Dollar Duration Weighted Yield Of Bonds**

\[ \text{Dollar Duration Weighted Yield Of Bonds} = \sum \frac{\text{Market Value Of Bond} \times \text{Duration Of Bond} \times \text{Yield Of Bond}}{\sum \text{Market Value Of Bond} \times \text{Duration Of Bond}} \]

\[ \div \quad \text{Portfolio Yield} \]
DEFINING DURATION

Macaulay Duration:

Present Value Weighted Average Time To Receipt Of Cash Flow

Modified Duration:

Price Sensitivity To Changes In Interest Rates

If Asset Is Option-Free:

1. Relationship Between Macaulay And Modified Duration
2. Use Macaulay Duration To Calculate Modified Duration

If Asset Has Options:

1. Macaulay Duration Has No Economic Interpretation
2. Use Option Pricing Models To Calculate Modified Duration
DURATION AS A RISK MEASURE

RISK : Possibility Of Not Achieving Desired Level Of Performance

DURATION MISMATCH : Used To Indicate Degree Of Risk

How Well Does Duration Mismatch Capture Risk?

1. Not Directly Related To Performance Measure

2. Presumes Symmetric Impact Of Interest Rate Changes

3. Ignores Path Dependency Of Cash Flows

4. Based On Marginal Instantaneous Changes In Rates
LIABILITY FUNDING CRITERIA

Basic Requirements For Liability Funding:

1. Meet Liability Payments As They Fall Due

2. Maintain Sufficient Assets To Meet Unextinguished Liabilities

3. Produce A Profit

Immunization:

1. Requires Duration Matching

2. Indirect Consideration Of Liability Requirements
MARKET VALUE

IMMUNIZATION

Slope = Duration

MV(A) = MV(L)

Y(A) = Y(L)

Asset

Liability

YIELD
MARKET VALUE

PICK UP YIELD MAINTAIN DURATION

Equal Durations

MV(A) = MV(L)

Y(L) Y(A) YIELD

YIELD

Asset

Liability
NOT IDENTIFIED BY IMMUNIZATION

Unequal Durations

MARKET VALUE

MV(A)
MV(L)

Y(L) Y(A)

Asset Liability

YIELD
FORMULATING AN INVESTMENT STRATEGY

Build A Framework For Measuring Performance And Risk:

1. Consider Multiple Scenarios Explicitly
2. Consider Multiple Horizons Explicitly
3. Performance Measure Valid For Both Assets and Liabilities
4. Risk Measure Calculated From Performance Measure
5. Quantifiable Risk-Return Trade-Off
6. Flexibility To Incorporate Margins For Error And Profit
SCENARIOS

Defining Scenarios:

1. Primarily Interest Rate Scenarios
2. Other Factors Can Define Scenarios
3. Can Be Generated By Stochastic Models e.g., Binomial Process
4. Can Incorporate Investor's Preferences

Advantages Of Scenario-Based Approach:

1. Explicit Evaluation Of A Range Of Possible Outcomes
2. Incorporates Path Dependency Of Cash Flows
3. Identifies Risky Environments Well In Advance
4. Allows For Changes In Factors Other Than Interest Rates
MULTIPLE HORIZONS

- Multiple Horizons Cater To Multiple Concerns
- Investor Has Short, Medium And Long Term Requirements
- Conventional Strategies Target Only One Horizon
- Desirable Strategy Should Target Multiple Horizons
TOTAL RETURN AS A PERFORMANCE MEASURE

CONVENTIONAL APPROACH

Total Return = Measure Past Performance
Yield/Spread = Forecast Future Performance
Duration = Aggregate Risk Control

DBL APPROACH - REALIZED RETURN OPTIMIZATION (RRO)

Total Return = Measure Past Performance
AND Forecast Future Performance
AND Risk Control
**RRO STRATEGY**

**REQUIRED RETURN = INVESTMENT TARGET:**

Total Return Required To Be Earned In A Scenario Over A Particular Horizon So That Liability Payments Are Made When Due And Sufficient Assets Remain To Cover Unextinguished Liabilities.

**REALIZED RETURN = PERFORMANCE MEASURE:**

Total Return Earned By The Assets In A Scenario Over A Particular Horizon

**INVESTMENT STRATEGY:**

In Each Scenario And Over Every Horizon

\[ \text{REALIZED RETURN} \geq \text{REQUIRED RETURN} \]
### EXAMPLE 1

**SELECTING A PORTFOLIO**

*(12-MONTH HORIZON)*

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROBABILITY</strong></td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>20%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td><strong>LIABILITY RETURN</strong></td>
<td>7.5%</td>
<td>8.0%</td>
<td>10.0%</td>
<td>10.5%</td>
<td>11.5%</td>
<td>9.75%</td>
</tr>
<tr>
<td><strong>MARGIN</strong></td>
<td>0.5%</td>
<td>1.0%</td>
<td>0.0%</td>
<td>0.5%</td>
<td>1.5%</td>
<td>0.65%</td>
</tr>
<tr>
<td><strong>REQUIRED RETURN</strong></td>
<td>8.0%</td>
<td>9.0%</td>
<td>10.0%</td>
<td>11.0%</td>
<td>13.0%</td>
<td>10.40%</td>
</tr>
</tbody>
</table>

**REALIZED RETURNS:**

| PORTFOLIO A     | 10.0%| 10.5%| 11.0%| 11.5%| 13.0%| 11.30%  |
| PORTFOLIO B     | 8.0% | 9.5% | 12.0%| 12.0%| 14.0%| 11.50%  |
IDENTIFYING AND MEASURING RISK

RISK: Possibility Of Not Achieving Target

RISK MEASUREMENT:

1. Standard Deviation About Average Portfolio Return
   • Ignores Liability Requirements

2. Total Deviation About Required Returns
   • Penalizes Both Underperformance And Overperformance

3. Downside Deviation About Required Returns
   • Penalizes Only Underperformance
### EXAMPLE 2

**RISK VS. RETURN**

(12-MONTH HORIZON)

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>AVERAGE</th>
<th>RISK (x 1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROBABILITY</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>20%</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIABILITY RETURN</td>
<td>7.5%</td>
<td>8.0%</td>
<td>10.0%</td>
<td>10.5%</td>
<td>11.5%</td>
<td>9.75%</td>
<td></td>
</tr>
<tr>
<td>MARGIN</td>
<td>0.5%</td>
<td>1.0%</td>
<td>0.0%</td>
<td>0.5%</td>
<td>1.5%</td>
<td>0.65%</td>
<td></td>
</tr>
<tr>
<td>REQUIRED RETURN</td>
<td>8.0%</td>
<td>9.0%</td>
<td>10.0%</td>
<td>11.0%</td>
<td>13.0%</td>
<td>10.40%</td>
<td></td>
</tr>
</tbody>
</table>

**REALIZED RETURNS:**

<table>
<thead>
<tr>
<th>PORTFOLIO C</th>
<th>9.0%</th>
<th>9.5%</th>
<th>10.0%</th>
<th>11.5%</th>
<th>12.0%</th>
<th>10.50%</th>
<th>DD</th>
<th>TD</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PORTFOLIO D</td>
<td>8.0%</td>
<td>8.0%</td>
<td>12.0%</td>
<td>12.0%</td>
<td>14.0%</td>
<td>11.20%</td>
<td>0.2</td>
<td>0.4</td>
<td>1.2</td>
</tr>
</tbody>
</table>

DD = DOWNSIDE DEVIATION FROM REQUIRED RETURNS
TD = TOTAL DEVIATION FROM REQUIRED RETURNS
SD = DEVIATION FROM PORTFOLIO AVERAGE RETURN
TOTAL RETURN

RRO
RISK VS. RETURN

SCENARIO CONTINUUM

Asset (SD)
Liability
Asset (DD)
Asset (TD)
RISK-RETURN TRADE-OFF

For Each Portfolio, Evaluate:

RETURN = Probability Weighted Realized Return

RISK = Downside Deviation From Required Return

RANK Portfolios By RETURN For Each Level Of RISK

RISK-RETURN FRONTIER:

• Maximum Return For Each Level Of Risk

• Quantifies Risk-Return Trade-off
FEASIBLE PORTFOLIOS

- ALL
- RRO
- IMMUNIZATION
- BOTH
SOME APPLICATIONS OF RRO

- Enabling Trading Across Markets
- Funding Life Insurance Liabilities
- Funding Pension Liabilities
- Maximizing Total Return
- Achieving Minimum Total Return In All Scenarios
- Enabling Active Management Of Interest Rate Risk
GENERAL ADVANTAGES OF RRO

- Flexible With Respect To Objectives And Targets
  - Allows For Multiple Investment Horizons
  - Accounts For Diverse Shifts In Interest Rates

- Handles Cash Flow Uncertainty Caused By Asset Options

- Identifies Untenable Positions Well In Advance

- Determines Risk-Return Frontier Based On Investor’s Targets

- Can Incorporate Margins For Profit And Error
ADVANTAGES OF RRO FOR LIABILITY FUNDING

- Ensures Ability To Meet Cash Outflows
- Matches Present Values Of Assets And Liabilities
- Handles Cash Flow Uncertainty Caused By Liability Options