ERM Symposium
April 2010

5D: Risk- Based Decision Making – Incorporating Risk Management into the Investment Process

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Mark Prindiville

Moderator
Curt Burmeister
Risk-Based Decision-Making

Incorporating Risk Management into the Investment Process

Dr. Andrew Aziz
Executive Vice President
Algorithmics Inc.

April 14th, 2010
Use of all available information

Means and co-variances...

Scenarios reveal greater granularity

A wide range of risk measures

Deviations in various directions
- Downside
- Upside
- All
- Net

Multiple measures calculated from the deviations
- VaR
- Sum of absolute deviations
- Expected sum
- Maximum
- Expected return
- Upside / Downside
- Expected sum of squares
- Tail expectation
Projections through time

Risk-Reward Statistics
- VaR, expected shortfall, etc
- PFE, CaR, EaR

Relative risk
- Tracking error, Surplus at risk
- LDI, ALM, economic capital

Risk across the balance sheet

Asset Portfolio

Liability Portfolio

Portfolio Replication Optimization

Replicating Portfolio
Risk in the investment process

Key Elements

1. Simulation and full revaluation
   • Scenarios on risk factors
   • Wide range of valuation models

2. What-if trades
   • Security level trades
   • Group level trades (Asset allocation)
   • Hedging

3. Portfolio Optimization
   • Scenario based optimization
   • Group and other constraints
   • Portfolio replication
Risk Assessment

- Market Event
- Cash In/out flow
- Changed Benchmark
- Routine Enquiry

Risk Assessment

Triggers
Analysis

Transparent simulation framework

Simulation

Mapping

Portfolios

Scenarios

Risk Factors

Models

\( f\{x, y\} \)

Valuation

Products

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Scenario Paths

A scenario is an internally-consistent evolution of future states

$t = 0$

$t = 1$

$t = 2$

$t = 3$

time steps

NA Bond Fund – VaR Report
NA Bond Fund – PV01 Report

What-if Trade

- Market Event
- Cash In/out flow
- Changed Benchmark
- Routine Enquiry

Risk Assessment

What-if

Triggers

Analysis

Tools
What-if Trade – Hedge USD PV01

USD PV01 After What-if Trade
What-if Trade

- Market Event
- Cash In/out flow
- Changed Benchmark
- Routine Enquiry

Triggers

Risk Assessment

Analysis

What-if

Tools

Analyze What-if Trade Across IR Shocks

- Graph showing risk assessment over time
Optimization

Market Event ➔ Cash In/out flow ➔ Changed Benchmark ➔ Routine Enquiry

Risk Assessment ➔ Analysis

Optimization ➔ Tools

Objective Functions

<table>
<thead>
<tr>
<th>Measure</th>
<th>Direction</th>
<th>Downside</th>
<th>Upside</th>
<th>All</th>
<th>Net</th>
</tr>
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<tbody>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Expectation</td>
<td>Regret</td>
<td></td>
<td></td>
<td>M.A.D.</td>
<td>Mean</td>
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<tr>
<td>Maximum</td>
<td>Worst Case</td>
<td></td>
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<td></td>
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<tr>
<td>Sum of Squares</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Exp Sum of Squares</td>
<td>Semi-variance</td>
<td></td>
<td></td>
<td></td>
<td>Variance, TE²</td>
</tr>
<tr>
<td>Tail Expectation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CVaR</td>
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</table>
Tracking Error Problem

Objective

\[ \min \sum_{j \in P} \sum_{k \in P} \sigma_j \left( w_j - w_j^B \right) \left( w_k - w_k^B \right) \]

Minimize variance of the active return (quadratic)

Constraints

\[ \sum_{j \in P} f_j w_j \geq R \]

Expected return is at least \( R \) (linear)

\[ \sum_{j \in P} w_j = 1 \]

No short positions

\[ w_j \geq 0 \text{ for all } j \in P \]

Weight of instrument \( j \) (decision variable)

NA Equity Fund & SP500 - TE
Optimization

- Market Event
- Cash In/out flow
- Changed Benchmark
- Routine Enquiry

Risk Assessment

- Triggers
- Analysis
- Tools

Optimal NA Equity Fund & SP500 – Minimize TE
Portfolio Replication

Investment applications
1. Liability based benchmarks for investment managers (LDI)
2. Hedging illiquid instruments with tradable instruments

Insurance applications
1. Economic capital
2. Sensitivity analysis and hedging
3. Regulatory capital & Solvency II

Intuition for Insurance Liabilities

Insurance contracts consist of building blocks
- Fixed cash flows → Zero Coupon Bonds
- Profit-sharing → Option on “upside”
- Lapsation → Option on “upside”
- Minimum Guarantees → Option on “downside”

Use these (simple) building blocks to replicate any insurance contract

<table>
<thead>
<tr>
<th>Value today</th>
<th>Value at target date</th>
</tr>
</thead>
<tbody>
<tr>
<td>instruments</td>
<td>scenarios</td>
</tr>
<tr>
<td>$q_1$</td>
<td>$s_1$</td>
</tr>
<tr>
<td>$q_2$</td>
<td>$s_2$</td>
</tr>
<tr>
<td>$q_3$</td>
<td>$s_3$</td>
</tr>
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</table>
Portfolio Replication Process

Output
Replicating portfolio = set of optimized weights (holdings) for the asset universe

Optimization Setup
Choice of objective function and attribute to be matched
Weight and trading cost constraints
Other constraints (duration, max # holdings, etc)

Liability Portfolio
Simulate liability portfolio across scenarios and through time calculating the relevant attributes (e.g. cash flow, THEO/Value)

Scenarios
Can be real world, risk neutral, stress tests, or combination
Must evolve all risk factors (e.g. IR, EQ, & FX) through time

Asset Universe
Simulate asset universe across scenarios and through time calculating relevant attributes (e.g. cash flow, THEO/Value, etc)

Optimization Problem
Pick asset holdings $x_k$ to minimize

$$\min_{x_k} \sum_{t=1}^{T} \left( \sum_{s=1}^{S} \left[ f_{liab}^{t}(s,t) - \sum_{k=1}^{K} x_k f_{asset}^{t,k}(s,t) \right] \right)$$

Deviation Measure
- Mean Absolute Error
- Mean Square Error
- ...

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Match (Linear) 20 Annual Time Steps $R^2 = .917$

Match (Linear) 5-5-5-5 Buckets $R^2 = .974$
Match (Linear)  5-5-10 Buckets  $R^2 = .970$

Match (Linear) – Mean Cash Flows
Match (Linear) – Std Dev Cash Flows

Match (Linear) – Stress Test Scenarios
Risk-Based Decision-Making

Incorporating Risk Management into the Investment Process

Mark Prindiville
Managing Director, Investment Research and Analytics

April 14th, 2010

The Evolution of Investment Risk Oversight at Allstate

- Investment Risk Management function established
- Proprietary analytics effort launched

- Portfolio Management function unified and enabled
- Algorithmics market risk system installed

- Individual Portfolios
- Risk Limits
- Bottom Up Process
- Emphasis on Security Selection
- Hedging of Securities
- Negative Portfolio Return Skew

- Enterprise Exposures
- Risk Targets
- Top Down / Bottom Up Process
- Equal Emphasis on Asset Allocation
- Hedging of Portfolios
- Downside Protection
Incorporating Risk Management into the Investment Process

**Measurement, Monitoring, Management**

- **Practical Examples**
  - Interest Rate Risk Management
  - Equity Risk Management
  - Pension Portfolio Management

- **Some Prerequisites**
  - Senior Leadership Vision and Support
  - Well-Defined Risk Objectives
  - Defined Responsibilities and Accountabilities
  - Comprehensive and Consistent Analytics
  - Assessment of Prospective Returns

**Interest Rate Risk Management**

- **Fixed Income Assets - Algo**
- **Liabilities - Life Company Actuarial System**

<table>
<thead>
<tr>
<th>Duration</th>
<th>Econ</th>
<th>Acctg</th>
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<tbody>
<tr>
<td>KRD</td>
<td></td>
<td></td>
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<tr>
<td>+100</td>
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<td>+200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+300</td>
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</tbody>
</table>

- **VaR**
- **VaR PC**
  - Parallel
  - Steepening
  - Butterfly
  - Swap Basis
  - Muni Basis

**Integration of Stress Tests**

- **Portfolio Actions**
  - Swaps
  - Swaptions

- **Derivatives Desk**
- **Evaluation of Hedging Strategies**
  - What-If Trade Analysis
- **Analytics Team**