Concentration Risk Measures and Deconcentration Optimization

Portfolio Optimization

CAS 2011 RPM Seminar
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Agenda

Section 1	Introduction to Catastrophe Risk Management
Section 2	Introduction to Portfolio Optimization

Section 1: Introduction to Catastrophe Risk Management

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Catastrophe Modeling 101

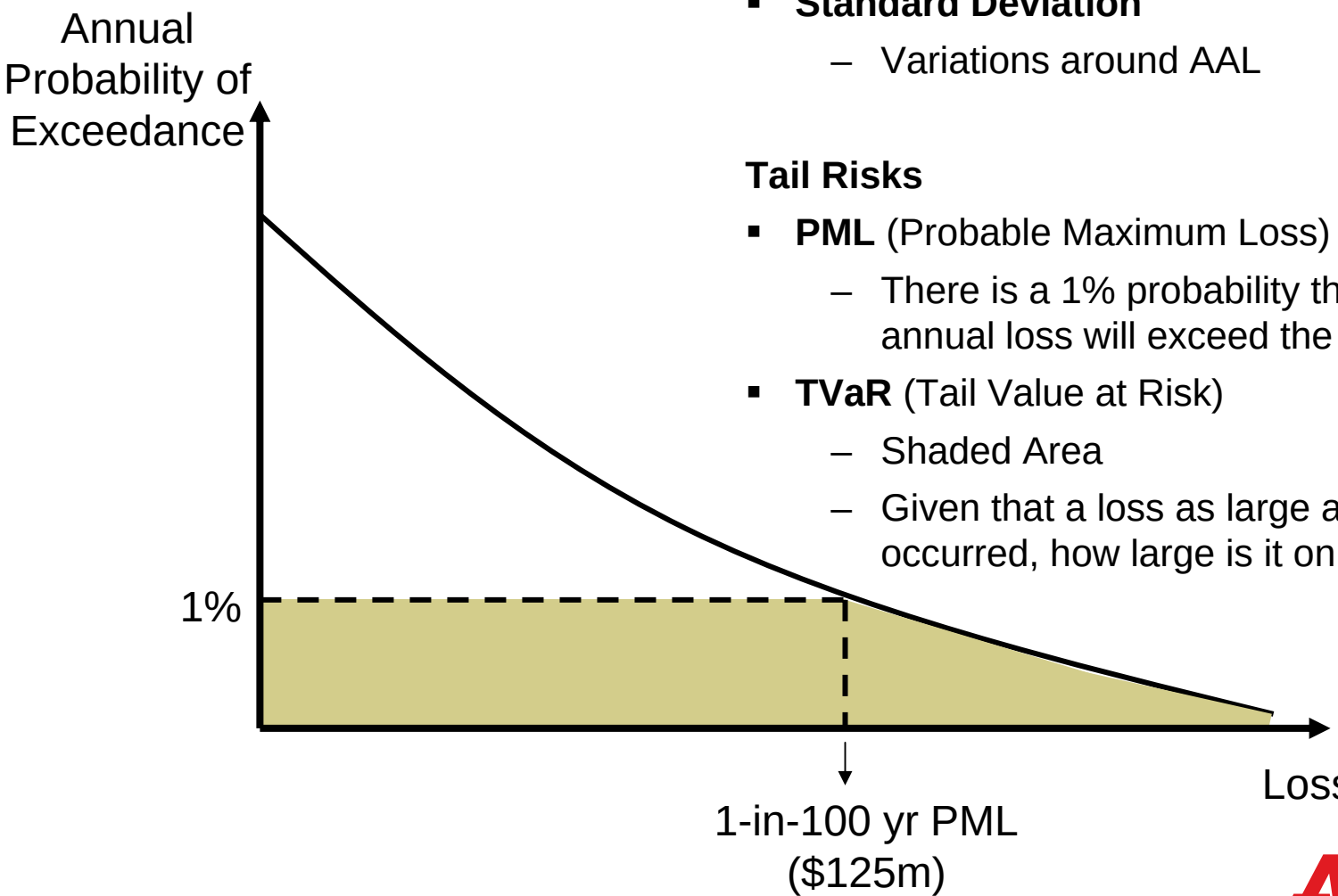
- **Input:**
  - **Detailed exposure information (location, construction class, year of built, etc)**
  - **Policy terms (limit, deductible, treaty information, etc)**

Hazard	Vulnerability	Financial
• Event Generation • Local Intensity Calculation	• Engineering/Building Performance • Mean Damage Ratio (MDR) Estimation • Distribution/ Uncertainty of MDR	• Insured Loss Calculation Based on Insurance and Reinsurance Terms • Incorporate Correlations Between Locations and Policies

- **Output:**
  - **Simulated catastrophe event losses by location/policy and aggregated to the portfolio level**
  - **Summary of catastrophe loss potentials in terms of AAL, SD, PML, TVaR, etc.**

Key Catastrophe Risk Metrics

- **AAL** (Average Annual Loss)
  - Entire area underneath the curve
- **Standard Deviation**
  - Variations around AAL



Tail Risks

- **PML** (Probable Maximum Loss)
  - There is a 1% probability that the portfolio annual loss will exceed the $125m
- **TVaR** (Tail Value at Risk)
  - Shaded Area
  - Given that a loss as large as $125m has occurred, how large is it on average?

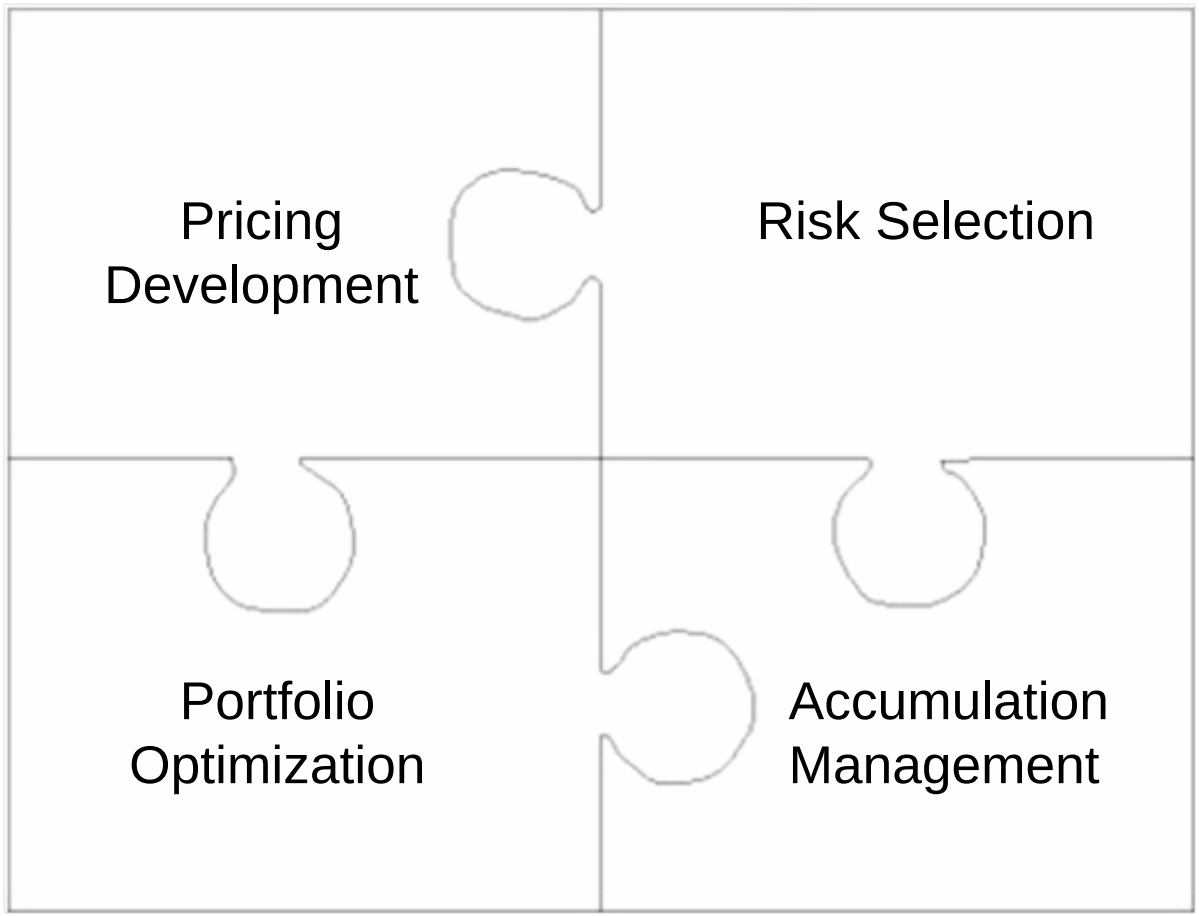
Catastrophe Risk Metrics
Sample Calculations

- Standard output from catastrophe models - An Event Loss Table containing simulated events and associated losses
  - Available at the policy level and aggregate to the portfolio level

A	B	C	D	E
Event ID	Event Rate	Portfolio Event Loss	Exceedance Prob	Return Period
1	0.002	27,000	0.0020	500
2	0.002	25,000	0.0040	250
3	0.002	20,000	0.0060	167
4	0.002	18,000	0.0080	125
5	0.002	15,000	0.0100	100
6	0.002	8,000	0.0119	84
7	0.002	6,000	0.0139	72
8	0.002	5,500	0.0159	63
9	0.002	5,000	0.0179	56
10	0.002	4,000	0.0198	50

AAL	267	sumproduct(B1:B10,C1:C10)
PML_{100}	15,000	C5
$TVaR_{100}$	21,084	sumproduct(B1:B5,C1:C5)/D5

Catastrophe Risk Underwriting Management



Section 2: Introduction to Portfolio Optimization

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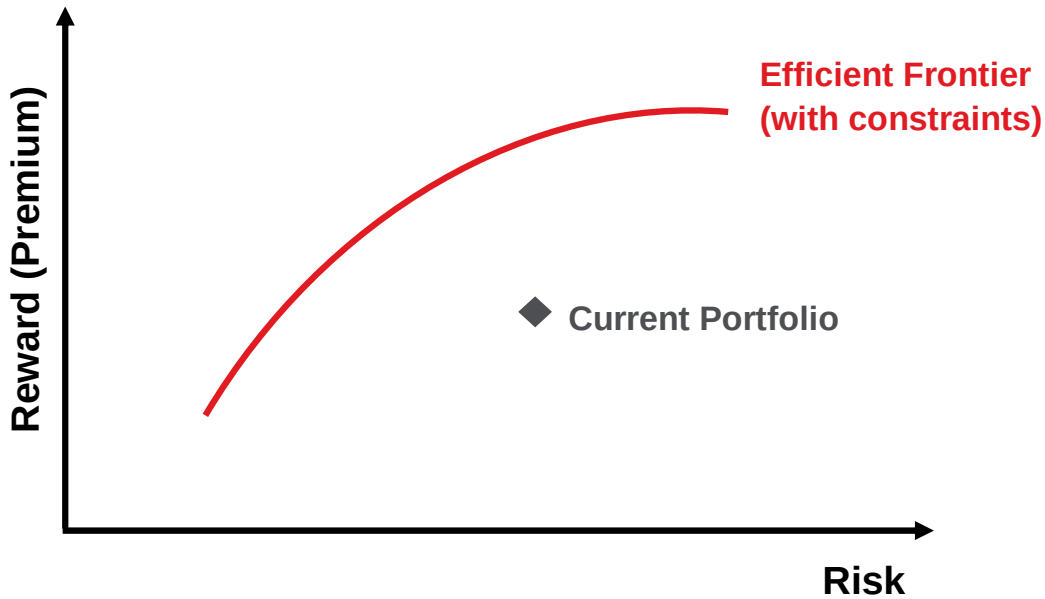
Introduction to Portfolio Optimization

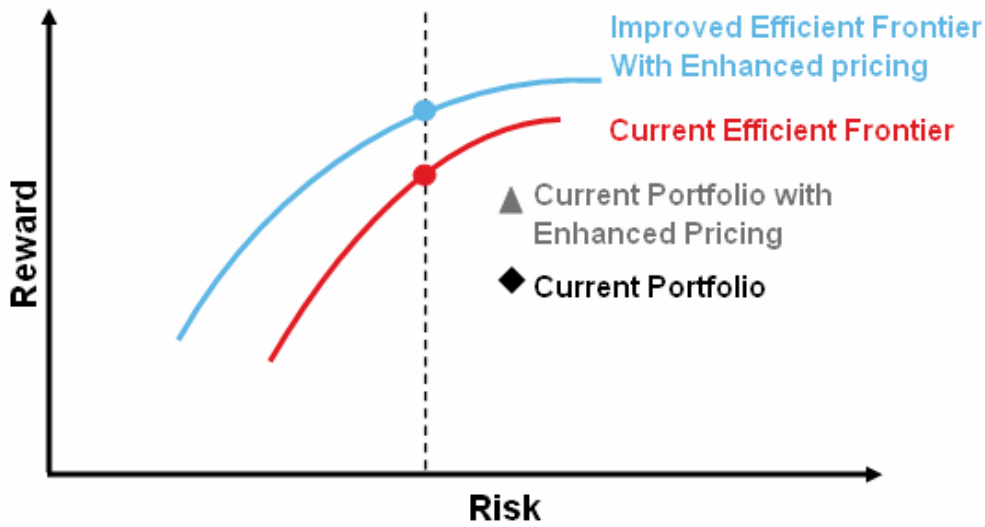
Moving Towards Efficient Frontier

1. Move the portfolio towards the efficient frontier, improving the risk -reward trade-off of an insurer's catastrophe portfolio
2. An efficient frontier is unique to each insurer and reflective of any business constraints; Each point on the efficient frontier is an optimal portfolio consisting of an unique combination of policies
3. Portfolio Optimization answers the question of 'what to write' in the context of insurance subject to catastrophe risk and current rate structure
4. Achieve efficient use of capital and better ROE



Pricing Based on Proper Cat Cost Allocation and Cat Score™
Moving The Efficient Frontier

1. Accurate/adequate pricing can move an insurer's Efficient Frontier
2. Aon Benfield provides estimation, allocation, and recovery of all costs associated with the transfer of catastrophe risk: AAL, reinsurance margin and cost of capital
   - Using industry-leading reinsurance cost allocation methodology
3. Cat Score® offers indicated total cat cost for individual prospective risks
   - Can be used to make accept/reject decisions when filed rate is fixed (accept when cat premium > cat score) or to make discretionary pricing adjustments when possible
   - Replace complex rule-based systems with clear cost-based decisions



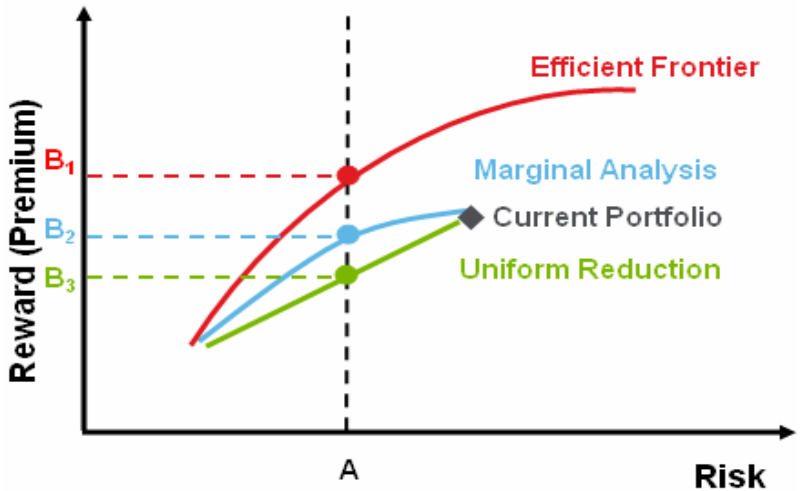
Dynamic Portfolio Optimization
Tail Risk Management

- Portfolio Optimization focuses on tail risk management
  - Tail risk drives rating agency ratings and cost of catastrophe reinsurance
  - Key element is the correlation of risk among policies
  - More sophisticated than approaches that simply examine expected loss to a policy (such as AAL)
    - AAL is additive and the contribution by a risk is independent of other risks
    - PML and TVaR contributions by a risk are highly dependent on all risks in the portfolio
  - Dynamic process
    - Adjust for changing character of the tail during the process

Marginal Risk Analysis And Dynamic Portfolio Optimization

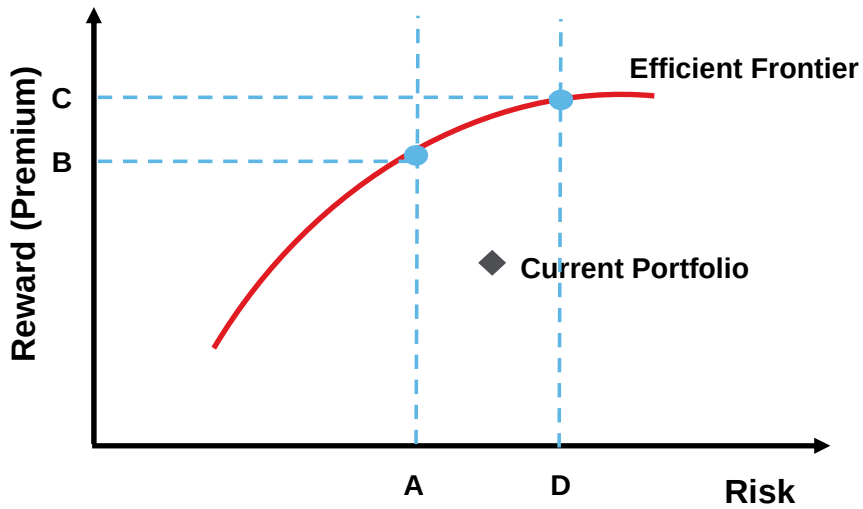
- Marginal Risk Analysis
  - A marginal risk analysis estimates the effect of adding/subtracting a policy to the current portfolio
  - Marginal TVaR for each policy can be calculated based on the policy's modeled losses from events driving the portfolio 1-in-100 year PML
  - Works well for small scale changes or as a snap shot of current risk drivers
  - For large scale changes, it ignores the fact that events driving the 1-in-100 year PML will change as one adds/subtract policies from the portfolio
  - Deconcentration analysis based on a marginal risk analysis will improve the portfolio efficiency but it may not lead to an insurer's Efficient Frontier

- Dynamic Portfolio Optimization (DPO)
  - Considers all combinations of events and policies
  - Guarantee global optimum for TVaR-based analyses (Efficient Frontier)



Dynamic Portfolio Optimization

- Optimality is achieved by finding the best combination of policies while satisfying specified business constraints
- Two ways to define an optimal portfolio
  1. Maximize reward: Given A, find B and the optimal portfolio
  2. Minimize risk: Given C, find D and the optimal portfolio



- Several algorithms are implemented at Aon Benfield, including Simulated Annealing and Stochastic Linear Programming; Details of these algorithms are beyond the scope/timeframe of this presentation

Sample Portfolio Optimization Project Specifications

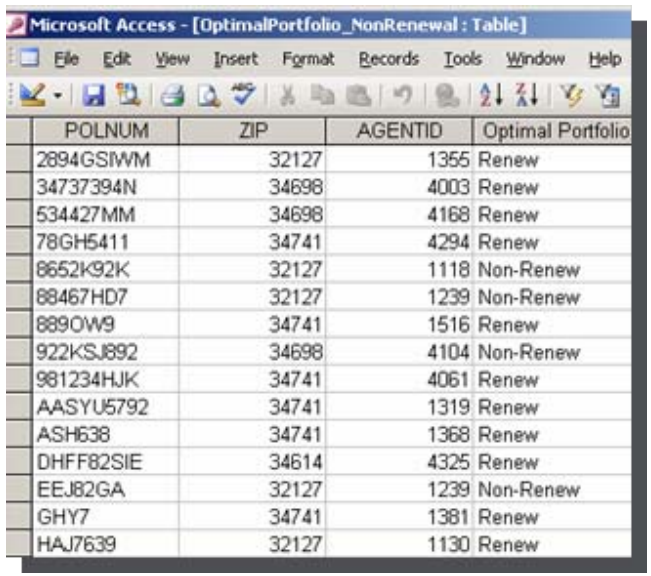
- Select optimization objective
- Choose optimization peril(s): Hurricane, Convective Storm, Earthquake or All Perils
- Define scope
  - Reduction, growth or both
  - Geographic area
  - Line of business
- Choose risk and reward metrics
  - Risk
    - PML or TVaR (with a specified return period)
  - Reward
    - Premium, Expected Profit, TIV or others
- Define new business specifications, if any
- Define constraints
  - For example, limit the % of non-renewal to 10% of each agent's premium or 10% TIV reduction for each postal code
- Decide modeling parameters
  - Catastrophe model(s), hurricane frequency assumption
- Decide on result resolution
  - By county, by postal code and by policy

Sample Portfolio Optimization Output

Summary Results:

Premium %	Premium (in $m)	100yr TVaR	TVaR to Premium	Change in TVaR (%)	AAL (in $m)	Change in AAL (%)	Policies Removed
Current	66.76	257.71	3.86	NA	13.16	NA	27,752
-1%	66.09	254.71	3.85	-5%	13.16	-5%	283
-2%	65.43	249.4	3.81	-8%	12.72	-8%	541
-3%	64.76	242.77	3.75	-10%	12.37	-10%	775
-4%	64.09	235.92	3.68	-13%	12.01	-13%	1,033
-5%	63.42	229.34	3.62	-15%	11.66	-15%	1,292
-6%	62.75	222.37	3.54	-18%	11.31	-18%	1,574
-7%	62.09	216.58	3.49	-20%	10.99	-20%	1,845
-8%	61.42	210.9	3.43	-22%	10.68	-23%	2,116
-9%	60.75	206.46	3.40	-24%	10.44	-24%	2,337
-10%	60.08	200.54	3.34	-26%	10.11	-27%	2,645

Policies to be considered for nonrenewal for a selected premium reduction %:



POLNUM	ZIP	AGENTID	Optimal Portfolio
2894GSIWM	32127	1355	Renew
34737394N	34698	4003	Renew
534427MM	34698	4168	Renew
78GH5411	34741	4294	Renew
8652K92K	32127	1118	Non-Renew
88467HD7	32127	1239	Non-Renew
889OW9	34741	1516	Renew
922KSJ892	34698	4104	Non-Renew
981234HJK	34741	4061	Renew
AASYU5792	34741	1319	Renew
ASH638	34741	1368	Renew
DHFF82SIE	34614	4325	Renew
EEJ82GA	32127	1239	Non-Renew
GHY7	34741	1381	Renew
HAJ7639	32127	1130	Renew

Portfolio Optimization Summary

- The goal to develop an underwriting/accumulation strategy that meets an insurer's risk management objective and satisfies all business constraints
- Careful quantification the business problem into numerical relationship is the key
- DPO solves for exposure distribution when targeting a large change in risk
- Deconcentration/Optimization analyses should be coordinated with pricing development and revisited periodically as rates/portfolio distribution/market conditions change
- More details available upon request

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