



A Reinsurer's Perspective on Capital and Property Cat Pricing
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Outline and Introduction:

- 1. Risk Management Culture and Attributed Capital**
How capital attribution fits into the broader company culture and risk management framework.
- 2. Managing Catastrophe Risk**
A brief discussion of how catastrophe risk is managed.
- 3. Property Portfolio Model:**
A description of one practical approach for combining catastrophe risk with attritional risk in an overall model.

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Risk Management Culture and Attributed Capital

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PartnerRe's Risk Management Culture

- Risk assumption and risk management are at the core of the company's value proposition
- Transparent risk management communication is emphasized both internally and externally
- Risk management and capital allocation are embedded:
 - In the strategy and stated goals of the company: To satisfy client needs and provide unquestioned ability to pay claims, while providing attractive risk adjusted returns to shareholders
 - In the thought processes of the company's underwriters, actuaries, capital modelers, investment professionals, accountants and others.

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Attributed Capital Is Part of the ERM Framework

- Senior management (and Board) risk appetite is expressed in terms of
 - limits: tolerance for tail loss events from specific large risks (and the impact of such events on the balance sheet)
 - volatility of earnings
 - solvency thresholds
- Models provide crucial volatility and tail risk metrics. Beyond the modeled results, additional loads reflect:
 - known un-modeled risks
 - unknown risks and parameter risk
- Attributed Capital and Pricing
 - Selected capital is attributed to the product line level. PartnerRe
 - Capital may be adjusted based on the treaty's individual features.

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Attributed Capital Serves Multiple Purposes

- Common view of risk across the organization achieved through attributing capital to every treaty and investment class
- Attributed capital forms the basis for
 - Determining deployed capital
 - Profitability measurement for pricing purposes
 - Hindsight performance measurement
- Principle and process of attributing capital
 - Each business unit has control over tactical capital deployment so diversification between classes within unit considered with the exception of catastrophe risk
 - Iterative process during plan and dynamic process during pricing. PartnerRe

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Managing Catastrophe Risk

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Managing Catastrophe Risk: Introduction

- Monitoring accumulations
 - Cat capacity may be reviewed separately for each geographic exposure zone and peril
 - Cat capacity may be managed using either
 - The limit (maximum foreseeable loss) from any one event
 - The modeled probable maximum loss from any one event
- The annual aggregate loss from multiple events could be used in the capital model.
- Models are part of a multi-faceted approach
 - Catastrophe models
 - Licensed from vendors
 - Proprietary internal models
 - Diversification by peril and geography
 - Qualitative underwriting

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Managing Catastrophe Risk: Pricing Approach

Pricing is based on a balance of information from:

- Catastrophe models, possibly more than one
- Loss history and actuarial techniques (sometimes useful for calibration)
- Additional methods for non-modeled perils

Balancing quantitative and qualitative analyses

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Managing Catastrophe Risk: Event Loss Tables

Event Number	Loss	Frequency	Description
1	29,253,000	0.0002%	Class 2 Hur FL
2	56,159,000	0.0005%	Class 3 Hur NY
3	34,896,000	0.0004%	Class 3 Hur MA
4	25,305,000	0.0004%	Class 3 Hur FL
5	44,888,000	0.0004%	.....
6	42,288,000	0.0004%	.....
7	46,400,000	0.0002%	.....
8	41,650,000	0.0004%	.....
9	37,983,000	0.0004%	.....
10	37,988,000	0.0003%	.....
11	38,430,000	0.0003%	.....
12	21,711,000	0.0004%	.....
13	23,800,000	0.0004%	.....
14	24,824,000	0.0004%	.....
15	25,429,000	0.0003%	.....
16	19,905,000	0.0002%	.....
17	19,858,000	0.0003%	.....
18	19,776,000	0.0004%	.....
19	19,702,000	0.0004%	.....
20	20,028,000	0.0002%	.....
21	20,068,000	0.0004%	.....
22	18,488,000	0.0002%	.....
23	8,668,000	0.0005%	.....
...			

→ Use table to compute expected loss and remote return period losses
→ Some major United States peril zones:

- South East Hurricane
- North East Hurricane
- Southern California Earthquake
- Northern California Earthquake

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Managing Catastrophe Risk: Secondary Perils

- All perils other than earthquake, hurricane, and terrorism are included along with attritional for capital modeling purposes. For example:
 - Convective Storm (Tornado, Hail, etc.)
 - Flood
 - Freeze, Winter Storms
- Estimation approaches:
 - Cat models are available for some peril zones
 - Experience rating
 - Fitting frequency and severity distributions and using Monte-Carlo simulation
 - Estimating the total market loss and then applying the company's market share

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Property Portfolio Model

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Property Portfolio Model Goals

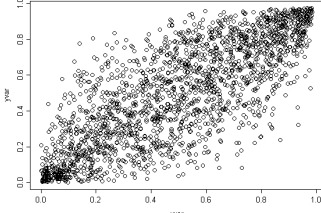
- Monitor Reinsurance Portfolio
 - Understand the risk-versus-return position of the business
 - How has it changed?
 - Where is it heading?
- Evaluate Strategic Decisions
 - Reinsurance purchase (retrocessional)
 - In addition to tail metrics, also consider how much a product line contributes to the variability of the total portfolio.
 - Overall variability will be driven more by the central bulk of the distribution (between the 10th and 90th percentiles).
 - Product line expansion / contraction
 - Acquisitions

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Property Model Background: Copulas

- Key idea: The correlation relationship is kept separate from the marginal distributions.
- Defined as the joint cumulative distribution function of two or more uniform random variables.
- Example: Gaussian with 80% correlation



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Property Model Background: Copulas

- Correlation Matrix
 - j by j matrix where j is the number of units in the model
 - The units could be treaties or product lines
 - Correlation coefficients represent the closeness of outcomes across units.
- More flexible than closed-form multivariate models:
 - With copulas, correlation assumptions are separate from individual distributions.
 - Copulas allow the freedom to model each marginal distribution using the best curve that the modeler can come up with.
- Two commonly used copulas are the Gaussian and Student's t . The t copula provides more correlation in the tail. Numerous other copulas can also be considered.

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Property Model Background: Copulas

- Hypothetical Correlation Matrix between product lines:

	Prop - Natl	Prop - Regl	Auto	Crop
Prop - Natl	100%			
Prop - Regl	75%	100%		
Auto	20%	20%	100%	
Crop	25%	25%	5%	100%

- Hypothetical Loss distribution
 - Represents a product line, such as property national

cumulative probability	loss ratio
10%	28%
20%	32%
30%	35%
40%	45%
50%	58%
60%	63%
70%	70%
80%	88%
90%	115%
95%	210%
98%	280%
97%	360%
98%	450%
99%	500%
99.9%	800%

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Property Model Background: Layering

Overall, the primary insurer cedes \$39M xs \$1M.

- 20 xs 20: Fourth excess layer
- 10 xs 10: Third excess layer
- 5 xs 5: Second excess layer
- 4 xs 1: First excess layer
- First million of each occurrence is retained by primary insurer.

- For each occurrence, losses above one million are ceded to reinsurers, split into four layers.
- In addition, per event limits might apply.

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Property Portfolio Model - Framework

- Attritional nominal loss distribution
 - Begin with individual reinsurance treaties
 - Combine to the product line level (using a copula)
 - Combine product lines to the portfolio level (using a copula)
 - Property is combined with casualty, agriculture, auto, etc.
- Catastrophe nominal loss: event table
- Total nominal loss (Nom Loss) = attritional + cat
- Financial Loss = $PV(\text{Nom Loss}) + PV(\text{Expenses}) - PV(\text{Premium})$
- Calculate metrics
 - VaR, TVaR, diversification ratios

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Property Portfolio Model - Attritional Loss Distribution

- Discrete model of how annual losses are spread over the range of possible outcomes.
- Selecting the distribution for a single treaty:
 - Estimate the probability that
 - a) the layer will be loss free
 - b) the probability of a full limit loss.
 - Validate the variability of the curve against experience.
 - Consider features that modify cash flows:
 - Annual Aggregate Deductible
 - Reinstatements
 - Loss Ratio Cap

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Prop. Model – Attritional Correlations Within a Line

- Select within-line (cross-treaty) correlations based on
 - Historical data
 - Layering: XOL reinsurance is often sold as a program of several layers. Losses within a program are correlated across layers.
 - Accumulation: Large buildings are frequently insured by multiple carriers. A reinsurer should consider whether different treaties cover the same property.
 - Proximity: can a single fire destroy many properties?
- Validate the resulting line distribution against history

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Prop. Model – Attritional Correlations Across Lines

- Industry data
- Geography: regional versus national
- Perils: for example consider weather
 - Storms are a key driver of property losses
 - Drought is a crucial driver of crop losses
 - Probably not closely related to casualty losses
- Rate adequacy: different lines may follow a similar underwriting cycle based on industry capital adequacy
- Macroeconomic forces:
 - Economic Inflation
 - Social Inflation (changes to the tort environment)
 - GDP growth

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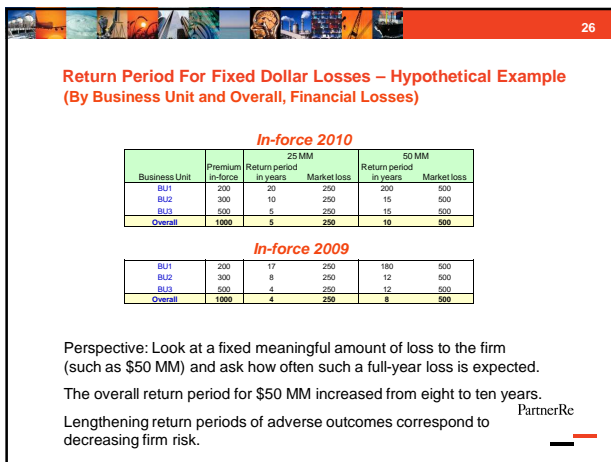
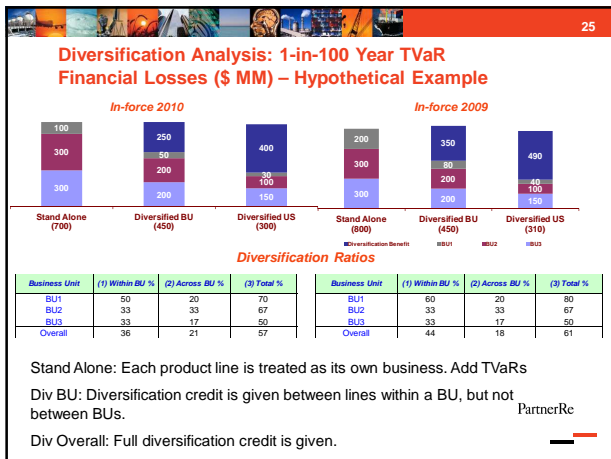
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Property Portfolio Model: Combining Attritional and Cat losses

Attritional: Fire and other non-Cat perils

Natural Catastrophe

Legend: ■ Loss ■ Premium



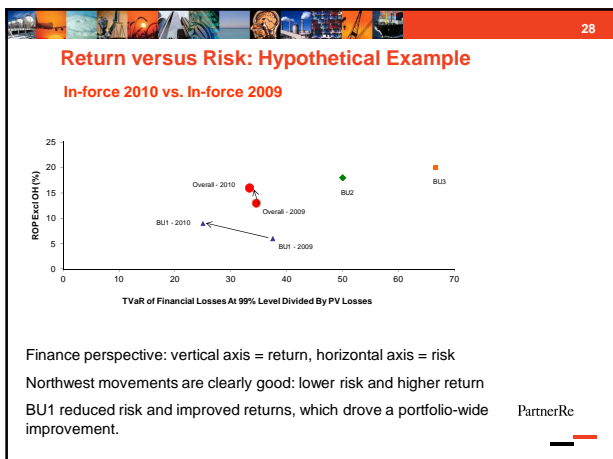
Event Set Analysis – Integrates Cat and Non-Cat Risk Hypothetical example centered around 100-year return period

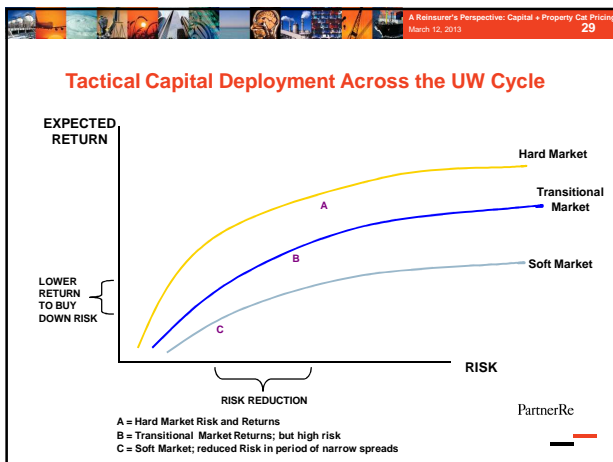
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Quantile	Agriculture		Casualty		Property		All Causes		Total	
	PV Profits	PV Tech Ratio	PV Profits	PV Tech Ratio	PV Profits	PV Tech Ratio	PV Profits	PV Tech Ratio		
98.95	5	90	(200)	140	90	(76)	90	(270)	120	
98.96	(10)	100	(130)	135	(40)	110	(61)	100	(271)	121
98.97	(5)	100	(70)	110	(130)	140	(66)	90	(271)	121
98.98	20	80	(200)	140	(20)	100	(72)	90	(272)	122
98.99	(20)	120	(130)	135	(30)	100	(62)	120	(272)	122
99.00	(10)	110	(25)	100	(160)	150	(78)	90	(273)	123
99.01	(20)	120	(200)	130	30	80	(83)	95	(273)	123
99.02	(10)	110	0	90	(250)	160	(14)	85	(274)	124
99.03	(10)	110	(150)	130	(50)	110	(64)	87	(274)	124
99.04	10	80	(200)	137	(10)	100	(75)	90	(275)	125
99.05	0	100	0	100	(200)	160	(75)	90	(275)	125

In-force 2009 – millions										
Quantile	Agriculture	Casualty	Property	All Causes	Total	Agriculture	Casualty	Property	All Causes	
98.95	(40)	110	0	90	(200)	160	(60)	90	(300)	125
98.96	10	90	50	80	(300)	190	(61)	90	(301)	126
98.97	(20)	100	70	80	(300)	190	(61)	85	(301)	126
98.98	(10)	100	0	90	(200)	160	(62)	100	(302)	127
98.99	30	80	(100)	120	(200)	160	(62)	75	(302)	127
99.00	(10)	100	(100)	120	(150)	140	(43)	75	(303)	128
99.01	5	90	(70)	110	(150)	140	(66)	100	(303)	128
99.02	(80)	125	(50)	100	(100)	120	(74)	95	(304)	129
99.03	10	90	(130)	125	(100)	120	(84)	100	(304)	129
99.04	(60)	135	(20)	100	(120)	125	(75)	95	(305)	130
99.05	0	90	(180)	150	(60)	110	(45)	75	(305)	130

Identify the drivers of tail outcomes for the portfolio.
 Determine which product lines contribute the most to TVaR.





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Conclusion

- A capital model should be part of a wider ERM framework
- When deploying capital, data flows in two directions:
 - 1. From the components up to the whole company:
 - Treaty exposure data flows into
 - attritional distributions
 - calculations of the company's estimated loss for each event in each cat event table
 - The attritional risk from all treaties is combined to the company level using the portfolio model. Cat risk is added.
 - 2. From the whole company down to the transaction level:
 - The portfolio model produces indicated capital
 - additional loads are embedded in the selected capital
 - Selected attributed capital flows back into treaty pricing

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Conclusion

- Substantial effort is required to parameterize a capital model. But estimating appropriate parameters is crucial in order to ensure that the model is suitable for decision making.
- Combining catastrophe risk with other risks in an overall portfolio model provides many benefits:
 - Tracking of key risk, return, and diversification metrics
 - Capital attribution
 - Strategic decision making

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