Optimal Insurance and Reinsurance Portfolios, Implied Pricing, Allocating Retrocessional Cost and Capital Allocation

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SUMMARY

A Basic Model

- Objectives/ Risk Preferences/Opportunity Set

B Important Features of Optimal Solution

- Implied Probabilities/Threshold Prices/ Marginal Value Of Capital

C Multi- Zone

- Allocating the Cost of Retrocession using Risk-Adjusted Probabilities

D Large Scale Applications

- Questions Posed and Answers Derived

Max Expected Ending Funds

Subject to;

Definitions of Funds at End Period…….all Scenarios
Premiums – Retro Costs – Losses + Recoveries

Risk Preference Constraints
Conditional Value at Risk Levels…….all Levels

Opportunity, Limits
Deals, Retrocession, Ratings, Balance Sheets

Non Negativities, etc. over all scenarios

Model Inputs	
Name	**Identification**
$\overline{bda}$	Bid/ask spread.
$\overline{c}_k$	Confidence level expressed as a decimal for risk level k
$\overline{capital}$	Starting capital
$\overline{cvar}_k$	Percent limit on loss of capital for risk level k
$\overline{loss}_{i,j}$	Unit loss of deal j in scenario i
$\overline{price}_j$	Price of deal j as a percent
$\overline{\rho}_i$	Probability of scenario i
$\overline{rate}$	Rate of return on investments
$\overline{tm}$	Percentage of capital as limit on total ceded premiums
$\overline{trs}$	Transaction costs as a percent

Decision Variables Determined by Model	
Name	**Identification**
α_k	Alpha value for risk *k*, which turns out to be VaR for active constraints
$deal_j$	Amount of premium of deal *j* written
$funds0$	Beginning period funds net of capital
$funds1_i$	End-of-period funds net of capital in scenario *i*
$gains_i$	Gains from recoveries in scenario *i*
$losses_i$	Losses in scenario *i*
$retro_j$	Amount of premium of deal *j* ceded
$z_{k,i}$	Excess loss over VaR of funds in scenario *i* for risk level *k*

$$\max_{funds0,\ funds1_i,\ z_i,\ \alpha_k,\ deal_j,\ retro_j,\ losses_i,\ gains_i} \quad \sum_{i \in I} \overline{p_i}\, funds1_i \qquad \text{expected value of funds at end of period} \tag{1}$$

Subject to;

$$funds0 - \sum_{j \in J} \left((1 - \overline{trs})(1 - \overline{bda})\, price_j deal_j - (1 + \overline{trs})(1 + \overline{bda})\, price_j retro_j \right) = 0 \tag{2}$$

Initial funds

$$funds1_i - \left(1 + \overline{rate}\right) funds0 + losses_i - gains_i = \overline{rate} \times \overline{capital} \tag{3}$$

End-of-period funds in scenario *i*

$$losses_i - \sum_{j \in J} deal_j \overline{loss_{i,j}} = 0 \qquad \text{Losses in scenario i} \tag{4}$$

$$gains_i - \sum_{j \in J} retro_j \overline{loss_{i,j}} = 0 \qquad \text{Gains in scenario i}$$

Equations (2), (3), and (4) can be collapsed into one but we keep them separate here for ease of exposition.

$$\sum_{j \in J} retro_j \le \overline{tm} \times \overline{capital} \qquad \text{Limit on retrocessions as a \% of capital} \tag{5}$$

$$-funds1_i - \alpha_k - z_{k,i} \le 0 \qquad \text{Value of excess loss by scenario i} \tag{6}$$

$$\sum_{i \in I} \overline{p_i} z_{k,i} + (1 - \overline{c_k})\alpha_k \le (1 - \overline{c_k})\, \overline{cvar_k} \times \overline{capital} \qquad \text{k CVaR constraints}$$

Bounds on deals and non-negativity constraints

$$0 \le deal_j \le \overline{\text{deal limit}_j} \qquad \text{Limit on deal} \tag{7}$$

$$0 \le retro_j \le \overline{\text{retro limit}_j} \qquad \text{Limit on retrocession}$$

$$-z_{k,i} \le 0 \qquad \text{Non-negativity constraint on excess loss}$$

$funds0,\ funds1_i,\ \alpha_k$ can otherwise take any value.

The dual objective is:

$$\min_{\substack{u_0,u_i,ul_i,ug_i,ucap \\ ucvar_k,uz_{k,i},ubd_j,ubr_juzl_{k,i}}} \sum_{k\in K}(1-\bar{c}_k)\overline{cvar_k}\times\overline{capital}\times ucvar_k + \overline{rate}\times\overline{capital}\sum_{i\in I}u_i$$

$$+\overline{tm}\times\overline{capital}\times ucap+\sum_{j\in J}ubd_j+\sum_{j\in J}ubr_j$$

Corresponding to the $funds0$

$$0 = u_0 - (1+\overline{rate})\sum_{i\in I}u_i$$

Corresponding to the $funds1_i$

$$\bar{\rho}_i = u_i - \sum_{k\in K}uz_{k,i}$$

Corresponding to the $deal_j$

$$0 = -p_j(1-\overline{trs})(1-\overline{bda})u_0 - \sum_i \overline{loss}_{i,j}\ ul_i + ubd_j$$

Corresponding to the $retro_j$

$$0 = p_j(1+\overline{trs})(1+\overline{bda})u_0 - \sum_i \overline{loss}_{i,j}\ ug_i + ucap + ubr_j$$

Corresponding to the $losses_i$ and $gains_i$

$$0 = u_i + ul_i$$
$$0 = -u_i + ug_i$$

Corresponding to the α_k

$$0 = -\sum_{i\in I}uz_{k,i} + (1-\bar{c})ucvar_k$$

Corresponding to the $z_{k,i}$

$$0 \le -uz_{k,i} + \bar{\rho}_i ucvar_k$$

We have the following constraints on the dual variables:

$$0 \le \begin{matrix} uone_j \\ ucap \\ uz_{k,i} \\ ucvar_k \end{matrix}$$

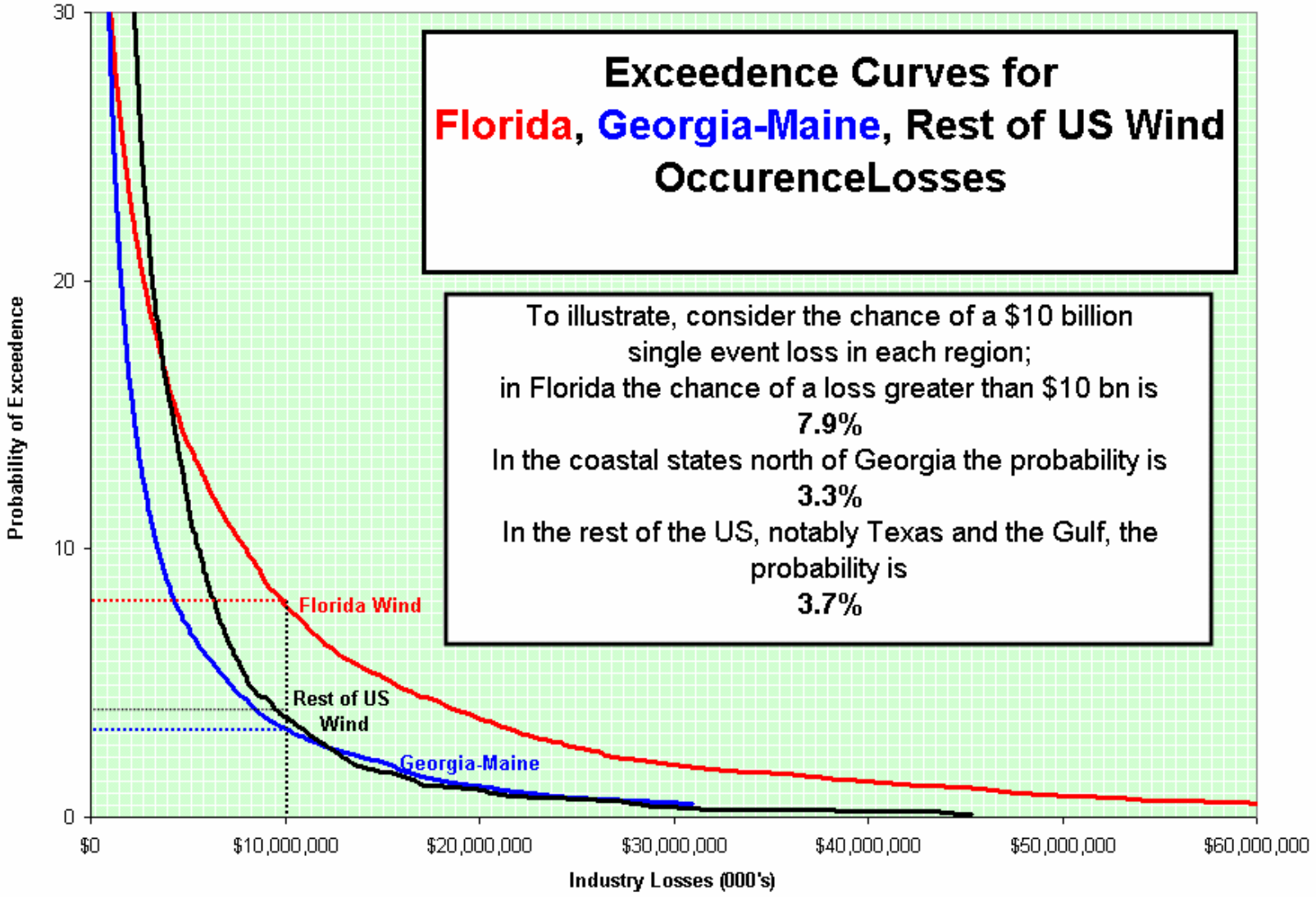
EQUIVALENCE OF PRIMAL-DUAL OBJECTIVES

(1)
$$\sum_{i\in I}\bar{\rho}_i\, funds1_i = \sum_{k\in K}(1-\bar{c}_k)\overline{cvar_k}\times\overline{capital}\times ucvar_k + \overline{rate}\times\overline{capital}\sum_{i\in I}u_i + \overline{tm}\times\overline{capital}\times ucap + \sum_{j\in J}ubd_j + \sum_{j\in J}ubr_j$$

Multiple Zones

Florida
Georgia – Maine
Rest of US
Nationwide Wind

Exceedence Curves for Florida, Georgia-Maine, Rest of US Wind OccurenceLosses



To illustrate, consider the chance of a $10 billion single event loss in each region;
in Florida the chance of a loss greater than $10 bn is
7.9%
In the coastal states north of Georgia the probability is
3.3%
In the rest of the US, notably Texas and the Gulf, the probability is
3.7%

Opportunity Set

INPUT PRICES	Reinsurance Asset/Liability Optimizer Prices			
Name	Florida Wind	Georgia to Maine Wind	Rest US Wind	Nationwide Wind
Tag	FlaWnd	GtMWnd	OthWnd	NWnd
Linkages				NWnd
Type	ILW	ILW	ILW	ILW
Distribution	FlaWnd	GtMWnd	OthWnd	FlaWnd,GtMWnd,OthWnd
Region	US	US	US	US
Trigger Point				
Billions	Wind	Wind	Wind	Wind
$1.0				
$1.5				
$2.0				
$3.0				
$5.0	26.00%	8.00%		28.00%
$7.5				
$10.0	17.50%	4.50%		20.00%
$12.5	15.00%	4.25%		17.00%
$15.0	13.00%	3.75%		14.50%
$20.0	9.50%	2.75%	2.00%	11.00%
$25.0	7.25%	2.00%		8.75%
$30.0	5.75%	1.75%		7.75%
$40.0	4.50%	1.50%		5.50%
$50.0	4.00%	1.00%		4.50%

Maximum written Limits

Name	Florida Wind	Georgia to Maine Wind	Rest US Wind	Nationwide Wind
Tag	FlaWnd	GtMWnd	OthWnd	NWnd
Linkages				NWnd
Type	ILW	ILW	ILW	ILW
Distribution	FlaWnd	GtMWnd	OthWnd	FlaWnd,GtMWnd,OthWnd
Region	US	US	US	US
Trigger				
Point				
Billions	Wind	Wind	Wind	Wind
$1.0				
$1.5				
$2.0				
$3.0				
$5.0	25	25		25
$7.5				
$10.0	25	25		25
$12.5	25	25		25
$15.0	25	25		25
$20.0	25	25	25	25
$25.0	25	25		25
$30.0	25	25		25
$40.0	25	25		25
$50.0	25	25		25

Maximum retrocession Limits

Name	Florida Wind	Georgia to Maine Wind	Rest US Wind	Nationwide Wind
Tag	FlaWnd	GtMWnd	OthWnd	NWnd
Linkages				NWnd
Type	ILW	ILW	ILW	ILW
Distribution	FlaWnd	GtMWnd	OthWnd	FlaWnd,GtMWnd,OthWnd
Region	US	US	US	US
Trigger				
Point				
Billions	Wind	Wind	Wind	Wind
$1.0				
$1.5				
$2.0				
$3.0				
$5.0	10	10		10
$7.5				
$10.0	10	10		10
$12.5	10	10		10
$15.0	10	10		10
$20.0	10	10	10	10
$25.0	10	10		10
$30.0	10	10		10
$40.0	10	10		10
$50.0	10	10		10

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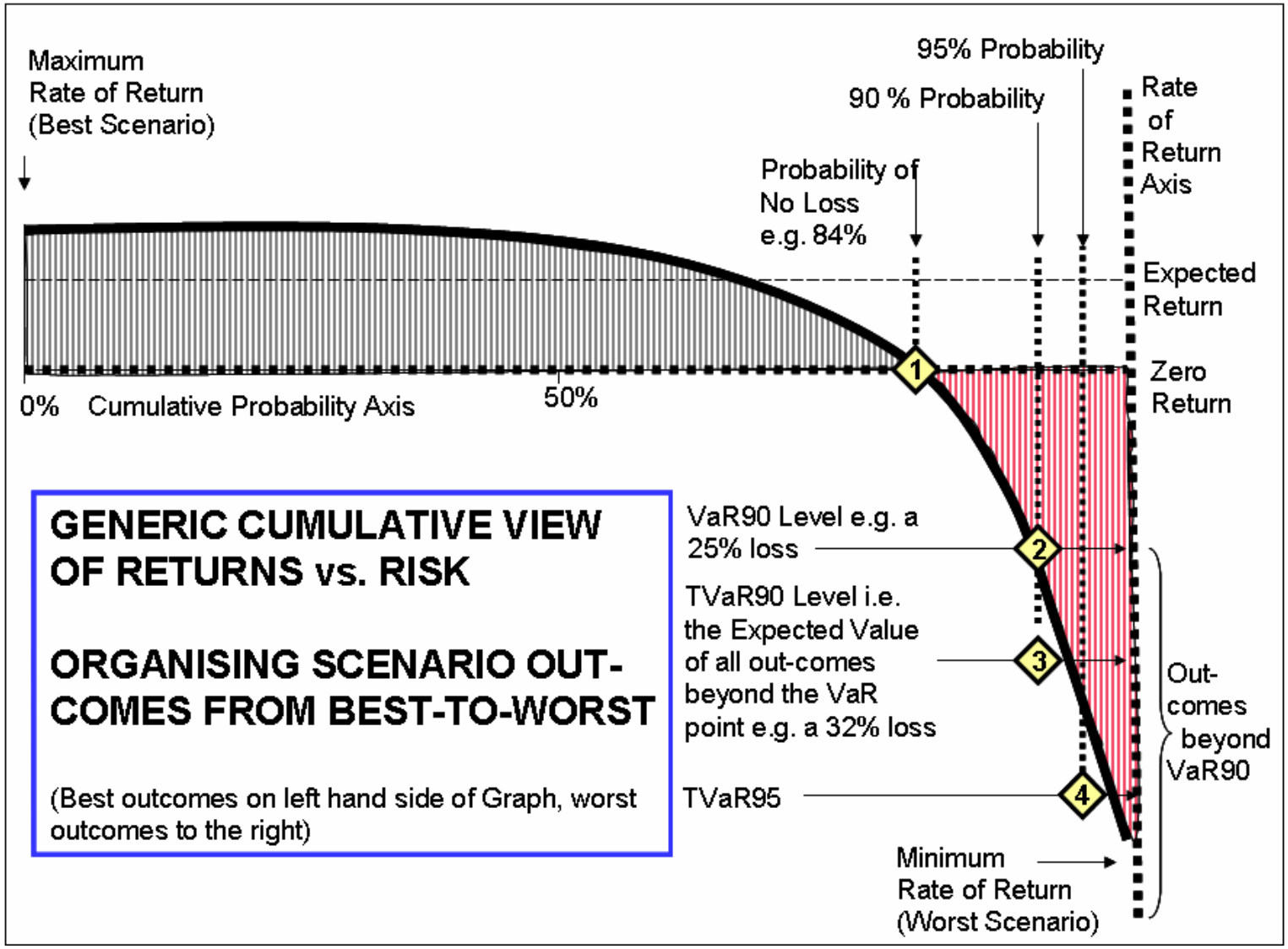
Risk Preferences

The risk preference constraints used are as follows:

Probability 30%, CVaR limit of 10% loss of risk capital
Probability 20%, CVaR limit of 20% loss of risk capital
Probability 0.1%, CVaR limit of 100% loss of risk capital

Figure 5


Maximum
Rate of Return
(Best Scenario)
95% Probability
90 % Probability
Rate
of
Return
Axis
Probability of
No Loss
e.g. 84%
Expected
Return
Zero
Return
0%
Cumulative Probability Axis
50%
1
GENERIC CUMULATIVE VIEW OF RETURNS vs. RISK
ORGANISING SCENARIO OUT-COMES FROM BEST-TO-WORST
(Best outcomes on left hand side of Graph, worst outcomes to the right)
VaR90 Level e.g. a
25% loss
2
TVaR90 Level i.e.
the Expected Value
of all out-comes
beyond the VaR
point e.g. a 32% loss
3
Out-
comes
beyond
VaR90
TVaR95
4
Minimum
Rate of Return
(Worst Scenario)

Optimal Solution

Trigger (Billions)	Florida Wind	Georgia to Maine Wind	Rest US Wind	Nationwide Wind	Totals by Layer	Percentage
$1.0						
$1.5						
$2.0						
$3.0						
$5.0	$19.14			-$10.00	$9.14	5.52%
$7.5						
$10.0	$25.00				$25.00	15.08%
$12.5	$25.00				$25.00	15.08%
$15.0	$25.00				$25.00	15.08%
$20.0	$13.30	$10.00	$10.00		$33.30	20.09%
$25.0						
$30.0						
$40.0		$25.00			$25.00	15.08%
$50.0	$10.00	$13.30			$23.30	14.06%
Totals by Zone	$117.44	$48.30	$10.00	-$10.00	$165.74	
Percentage	70.86%	29.14%	6.03%	-6.03%		100.00%

Threshold Prices

ILW		Florida Wind							
Trigger (Billiions)	Available Price (Pre-bid/ask)	Threshold Price	Available Cover Limit	Optimal Solution	Cover Marginal	Retro Threshold Price	Available Retro Limit	Optimal Retro	Retro Marginal
$1.0									
$1.5									
$2.0									
$3.0									
$5.0	26.00%	26.00%	25	**$19.14**		20.45%	10		-6.11%
$7.5									
$10.0	17.50%	15.99%	25	**$25.00**	1.36%	12.53%	10		-5.47%
$12.5	15.00%	13.41%	25	**$25.00**	1.43%	10.49%	10		-4.96%
$15.0	13.00%	12.03%	25	**$25.00**	0.88%	9.43%	10		-3.93%
$20.0	9.50%	9.50%	25	**$13.30**		7.47%	10		-2.23%
$25.0	7.20%	7.47%	25		-0.24%	5.88%	10		-1.45%
$30.0	5.80%	6.21%	25		-0.37%	4.90%	10		-0.99%
$40.0	4.50%	5.20%	25		-0.63%	4.11%	10		-0.43%
$50.0	4.00%	4.00%	25	**$10.00**		3.15%	10		-0.94%

Threshold Prices

ILW	Georgia to Maine Wind								
Trigger (Billiions)	Available Price (Pre-bid/ask)	Threshold Price	Available Cover Limit	Optimal Solution	Cover Marginal	Retro Threshold Price	Available Retro Limit	Optimal Retro	Retro Marginal
$1.0									
$1.5									
$2.0									
$3.0									
$5.0	8.00%	10.09%	25		-1.88%	8.00%	10		
$7.5									
$10.0	4.50%	5.52%	25		-0.91%	4.37%	10		-0.14%
$12.5	4.30%	4.70%	25		-0.36%	3.71%	10		-0.65%
$15.0	3.70%	3.92%	25		-0.19%	3.09%	10		-0.68%
$20.0	2.80%	2.80%	25	**$10.00**		2.20%	10		-0.66%
$25.0	2.00%	2.00%	25		0.00%	1.57%	10		-0.47%
$30.0	1.80%	1.82%	25		-0.02%	1.43%	10		-0.41%
$40.0	1.50%	0.91%	25	**$25.00**	0.53%	0.70%	10		-0.88%
$50.0	1.00%	1.00%	25	**$13.30**		0.79%	10		-0.23%

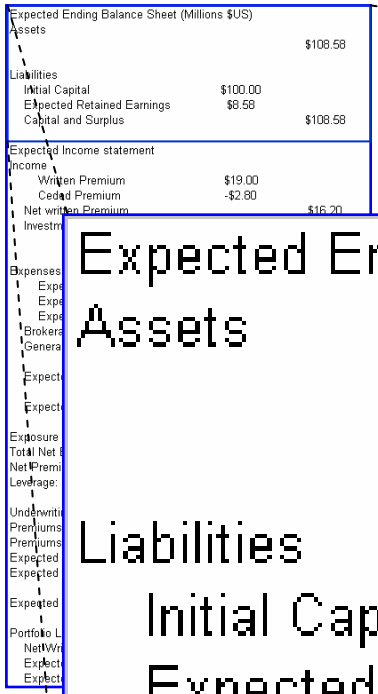
Threshold Prices

ILW		Rest US Wind							
Trigger (Billiions)	Available Price (Pre-bid/ask)	Threshold Price	Available Cover Limit	Optimal Solution	Cover Marginal	Retro Threshold Price	Available Retro Limit	Optimal Retro	Retro Marginal
$1.0									
$1.5									
$2.0									
$3.0									
$5.0									
$7.5									
$10.0									
$12.5									
$15.0									
$20.0	2.00%	2.00%	25	**$10.00**		1.57%	10		-0.47%
$25.0									
$30.0									
$40.0									
$50.0									

Threshold Prices

ILW		Nationwide Wind							
Trigger (Billiions)	Available Price (Pre-bid/ask)	Threshold Price	Available Cover Limit	Optimal Solution	Cover Marginal	Retro Threshold Price	Available Retro Limit	Optimal Retro	Retro Marginal
$1.0									
$1.5									
$2.0									
$3.0									
$5.0	28.00%	43.69%	25		-14.12%	34.85%	10	$10.00	7.54%
$7.5									
$10.0	20.00%	23.64%	25		-3.27%	18.71%	10		-1.42%
$12.5	17.00%	19.28%	25		-2.05%	15.23%	10		-1.95%
$15.0	14.50%	16.58%	25		-1.87%	13.10%	10		-1.54%
$20.0	11.00%	12.81%	25		-1.63%	10.13%	10		-0.96%
$25.0	8.70%	9.92%	25		-1.10%	7.84%	10		-0.95%
$30.0	7.70%	8.16%	25		-0.41%	6.43%	10		-1.40%
$40.0	5.50%	6.50%	25		-0.90%	5.14%	10		-0.39%
$50.0	4.50%	4.85%	25		-0.31%	3.83%	10		-0.74%

Expected Ending Balance Sheet (Millions $US)		
Assets		
		$108.58
Liabilities		
Initial Capital	$100.00	
Expected Retained Earnings	$8.58	
Capital and Surplus		$108.58
Expected Income statement		
Income		
Written Premium	$19.00	
Ceded Premium	-$2.80	
Net written Premium		$16.20
Investment Income		$0.00
		$16.20
Expenses		
Expected Losses	-$8.39	
Expected Recoveries	$2.95	
Expected Net Losses		-$5.44
Brokerage & Acquisition expense		-$2.18
General & Administrative		$0.00
Expected Profit		$8.58
Expected Rate on Equity		8.58%
Exposure Report		
Total Net Exposure		$155.74
Net Premium to Net Cover		0.10
Leverage: Exposure/Capital		1.56
Underwriting Report		
Premiums Written		$19.00
Premiums Ceded		-$2.80
Expected Losses		-$8.39
Expected Recoveries		$2.95
Expected Underwriting Profit		$10.76
Portfolio Loss Ratios		
Net Written Premiums		$16.20
Expected Net Losses		$5.44
Expected Net Loss Ratio		33.57%



Expected Ending Balance Sheet (Millions $US)

Assets

		$108.58

Liabilities

Initial Capital	$100.00	
Expected Retained Earnings	$8.58	
Capital and Surplus		$108.58

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Expected Ending Balance Sh
Assets

Liabilities
Initial Capital
Expected Retained Earnin
Capital and Surplus

Expected Income statement
Income
Written Premium
Ceded Premium
Net written Premium
Investment Income

Expenses
Expected Losses
Expected Recoveries
Expected Net Losses
Brokerage & Acquisition e
General & Administrative

Expected Profit

Expected Rate on Equity

Exposure Report
Total Net Exposure
Net Premium to Net Cover
Leverage: Exposure/Capital

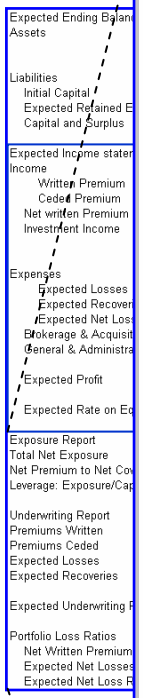
Underwriting Report
Premiums Written
Premiums Ceded
Expected Losses
Expected Recoveries

Expected Underwriting Profit

Portfolio Loss Ratios
Net Written Premiums
Expected Net Losses
Expected Net Loss Ratio

Expected Income statement

Income		
Written Premium	$19.00	
Ceded Premium	-$2.80	
Net written Premium		$16.20
Investment Income		$0.00
		$16.20
Expenses		
Expected Losses	-$8.39	
Expected Recoveries	$2.95	
Expected Net Losses		-$5.44
Brokerage & Acquisition expense		-$2.18
General & Administrative		$0.00
Expected Profit		$8.58
Expected Rate on Equity		8.58%



Exposure Report	
Total Net Exposure	$155.74
Net Premium to Net Cover	0.10
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Underwriting Report	
Premiums Written	$19.00
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Expected Losses	-$8.39
Expected Recoveries	$2.95
Expected Underwriting Profit	$10.76
Portfolio Loss Ratios	
Net Written Premiums	$16.20
Expected Net Losses	$5.44
Expected Net Loss Ratio	33.57%

RANKING THE WRITES

Zone	Trigger (Billiions)	Available Price (Pre-bid/ask)	Threshold Price	Available Cover Limit	Optimal Solution	Cover Marginal
FLA	$12.5	15.00%	13.41%	25	**$25.00**	1.43%
FLA	$10.0	17.50%	15.99%	25	**$25.00**	1.36%
FLA	$15.0	13.00%	12.03%	25	**$25.00**	0.88%
GEO	$40.0	1.50%	0.91%	25	**$25.00**	0.53%
GEO	$50.0	1.00%	1.00%	25	**$13.30**	0.00%
RUS	$20.0	2.00%	2.00%	25	**$10.00**	0.00%
GEO	$20.0	2.80%	2.80%	25	**$10.00**	0.00%
FLA	$50.0	4.00%	4.00%	25	**$10.00**	0.00%
FLA	$20.0	9.50%	9.50%	25	**$13.30**	0.00%
FLA	$5.0	26.00%	26.00%	25	**$19.14**	0.00%
GEO	$25.0	2.00%	2.00%	25		0.00%
GEO	$30.0	1.80%	1.82%	25		-0.02%
GEO	$15.0	3.70%	3.92%	25		-0.19%
FLA	$25.0	7.20%	7.47%	25		-0.24%
NWW	$50.0	4.50%	4.85%	25		-0.31%
GEO	$12.5	4.30%	4.70%	25		-0.36%
FLA	$30.0	5.80%	6.21%	25		-0.37%
NWW	$30.0	7.70%	8.16%	25		-0.41%
FLA	$40.0	4.50%	5.20%	25		-0.63%
NWW	$40.0	5.50%	6.50%	25		-0.90%
GEO	$10.0	4.50%	5.52%	25		-0.91%
NWW	$25.0	8.70%	9.92%	25		-1.10%
NWW	$20.0	11.00%	12.81%	25		-1.63%
NWW	$15.0	14.50%	16.58%	25		-1.87%
GEO	$5.0	8.00%	10.09%	25		-1.88%
NWW	$12.5	17.00%	19.28%	25		-2.05%
NWW	$10.0	20.00%	23.64%	25		-3.27%
NWW	$5.0	28.00%	43.69%	25		-14.12%

RANKING THE RETROS

Zone	Trigger (Billiions)	Retro Threshold Price	Available Retro Limit	Optimal Retro	Retro Marginal
NWW	$5.0	34.85%	10	**$10.00**	7.54%
GEO	$5.0	8.00%	10		0.00%
GEO	$10.0	4.37%	10		-0.14%
GEO	$50.0	0.79%	10		-0.23%
NWW	$40.0	5.14%	10		-0.39%
GEO	$30.0	1.43%	10		-0.41%
FLA	$40.0	4.11%	10		-0.43%
GEO	$25.0	1.57%	10		-0.47%
RUS	$20.0	1.57%	10		-0.47%
GEO	$12.5	3.71%	10		-0.65%
GEO	$20.0	2.20%	10		-0.66%
GEO	$15.0	3.09%	10		-0.68%
NWW	$50.0	3.83%	10		-0.74%
GEO	$40.0	0.70%	10		-0.88%
FLA	$50.0	3.15%	10		-0.94%
NWW	$25.0	7.84%	10		-0.95%
NWW	$20.0	10.13%	10		-0.96%
FLA	$30.0	4.90%	10		-0.99%
NWW	$30.0	6.43%	10		-1.40%
NWW	$10.0	18.71%	10		-1.42%
FLA	$25.0	5.88%	10		-1.45%
NWW	$15.0	13.10%	10		-1.54%
NWW	$12.5	15.23%	10		-1.95%
FLA	$20.0	7.47%	10		-2.23%
FLA	$15.0	9.43%	10		-3.93%
FLA	$12.5	10.49%	10		-4.96%
FLA	$10.0	12.53%	10		-5.47%
FLA	$5.0	20.45%	10		-6.11%

Optimal Risk Report for problem: Multi zone wind. Generated on 08/13/05 and time 17:10:11

Capital (Million)	100
Transaction Cost%	10.00%
Bid/Ask Spread%	0.00%
Investment Return%	0.00%
Retro Limit as %Capital	50.00%

Problem Class	Distribution Based
Model Name	basicmod.gms

Risk Actual, Limits, and Technical Data

Prob%	VaR %Loss	CVaR %Loss	Limit CVaR	Alpha	Dual	
30.00%	14.02%	-8.66%	-10.00%	-11.47	0.00	
20.00%	14.02%	-20.00%	-20.00%	-14.02	0.67	Binding
0.10%	-93.42%	-100.00%	-100.00%	93.42	41.09	Binding

Other Solution Information and VaR and CVaR Values

Written Premium	19.00
Ceded Premium	2.80
Expected Retained Earnings	8.58
Marginals on Retrocession Maximum	0.00

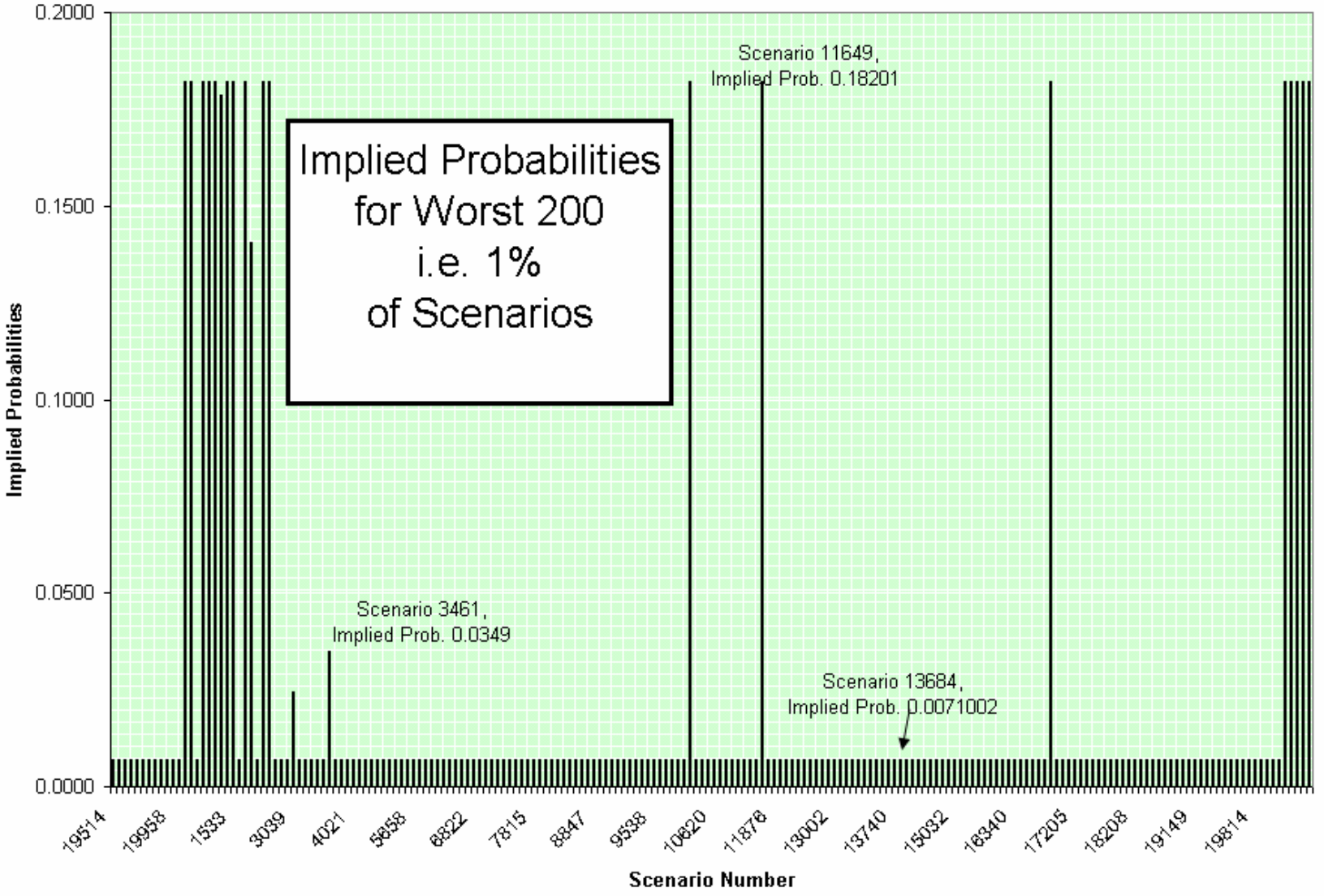
Risk adjusted marginal return on capital	6.78%
Marginal return per dollar of non-risk capital	17.47%

VaR and CVaR Values along the Distribution

Prob%	VaR %Loss(-)	CVaR %Loss(-)
100.00%	24.02%	8.58%
90.00%	24.02%	6.87%
80.00%	14.02%	5.52%
70.00%	14.02%	4.30%
60.00%	14.02%	2.68%
50.00%	14.02%	0.41%
40.00%	14.02%	-2.99%
30.00%	14.02%	-8.66%
20.00%	14.02%	-20.00%
10.00%	4.88%	-50.16%
9.00%	4.88%	-56.27%
8.00%	-20.12%	-63.71%
7.00%	-20.12%	-69.94%
6.00%	-45.12%	-77.20%
5.00%	-70.12%	-82.12%
4.00%	-70.12%	-85.12%
3.00%	-83.42%	-86.77%
2.00%	-83.42%	-88.45%
1.00%	-83.42%	-93.48%
0.90%	-93.42%	-94.15%
0.80%	-93.42%	-94.24%
0.70%	-93.42%	-94.36%
0.60%	-93.42%	-94.52%
0.50%	-93.42%	-94.74%
0.40%	-93.42%	-95.07%
0.30%	-93.42%	-95.61%
0.20%	-93.42%	-96.71%
0.10%	-93.42%	-100.00%
0.09%	-93.42%	-100.73%
0.08%	-93.42%	-101.65%
0.07%	-93.42%	-102.82%
0.06%	-93.42%	-104.39%
0.05%	-93.42%	-106.58%
0.04%	-93.42%	-109.87%
0.03%	-93.42%	-115.35%
0.02%	-103.42%	-123.82%
0.01%	-131.72%	-136.72%
5.0E-05	-141.72%	-141.72%
0.00%	-141.72%	-141.72%

Optimal Solution

Trigger (Billions)	Florida Wind	Georgia to Maine Wind	Rest US Wind	Nationwide Wind	Totals by Layer	Percentage
$1.0						
$1.5						
$2.0						
$3.0						
$5.0	$19.14			-$10.00	$9.14	5.52%
$7.5						
$10.0	$25.00				$25.00	15.08%
$12.5	$25.00				$25.00	15.08%
$15.0	$25.00				$25.00	15.08%
$20.0	$13.30	$10.00	$10.00		$33.30	20.09%
$25.0						
$30.0						
$40.0		$25.00			$25.00	15.08%
$50.0	$10.00	$13.30			$23.30	14.06%
Totals by Zone	$117.44	$48.30	$10.00	-$10.00	$165.74	
Percentage	70.86%	29.14%	6.03%	-6.03%		100.00%



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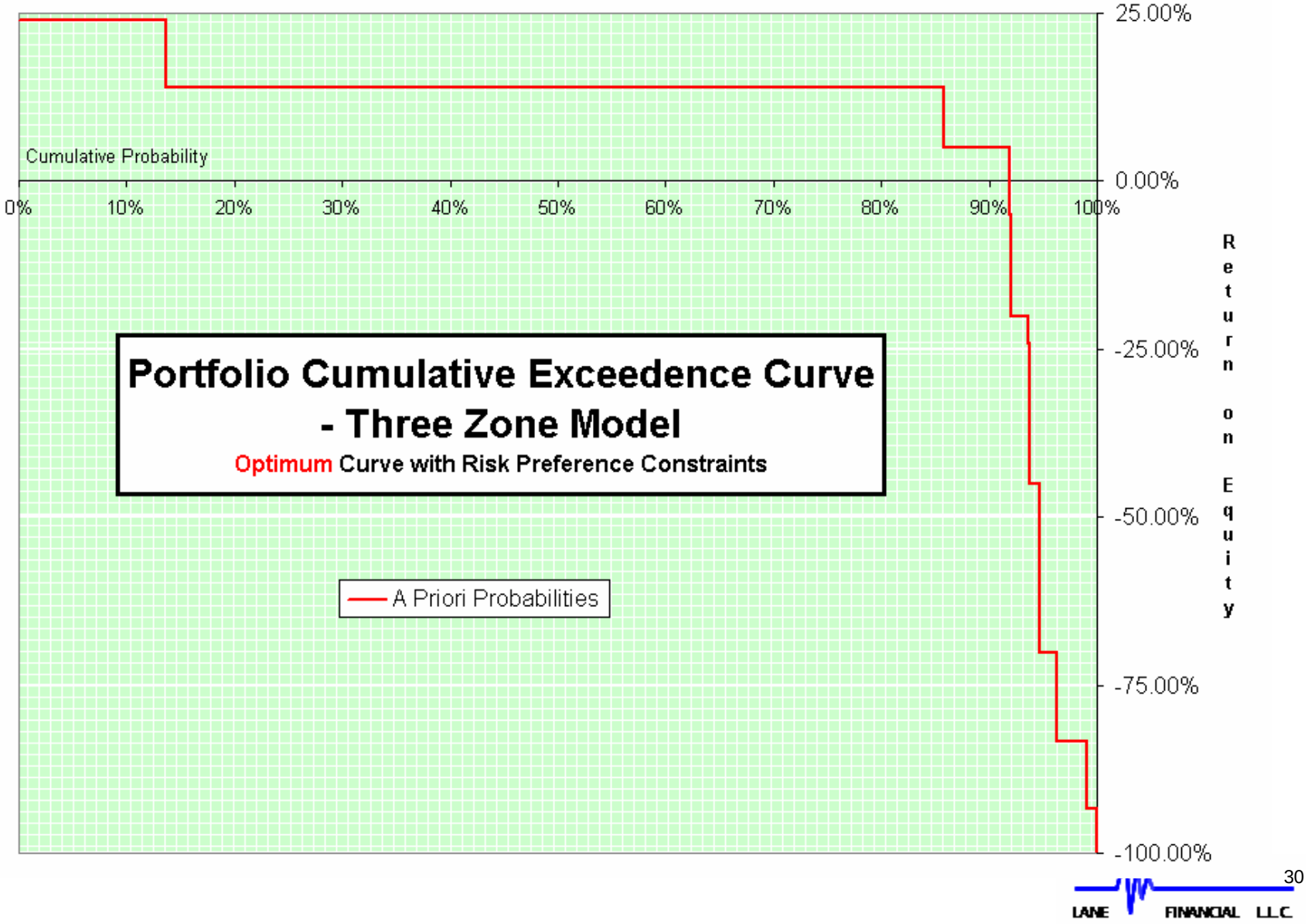
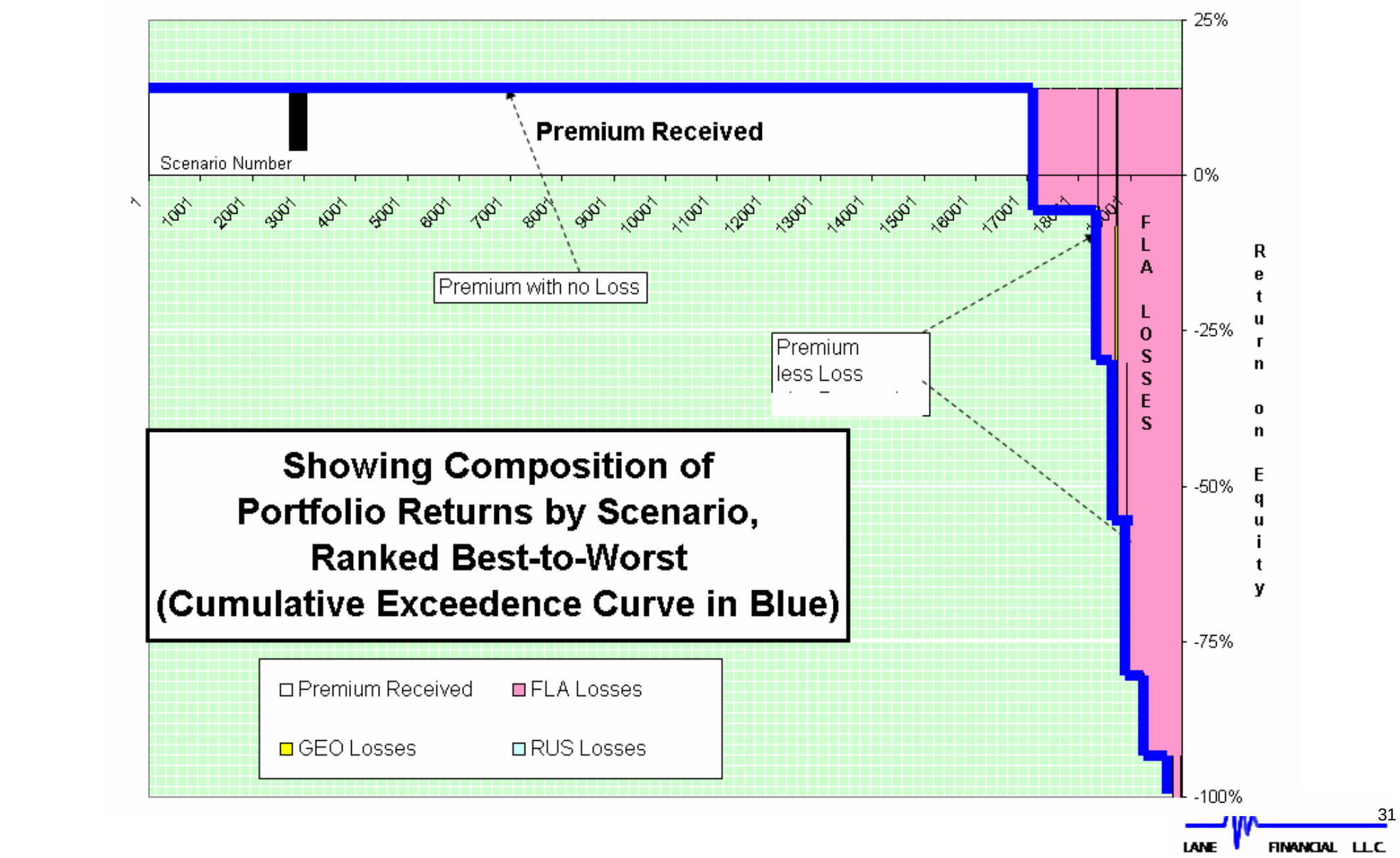
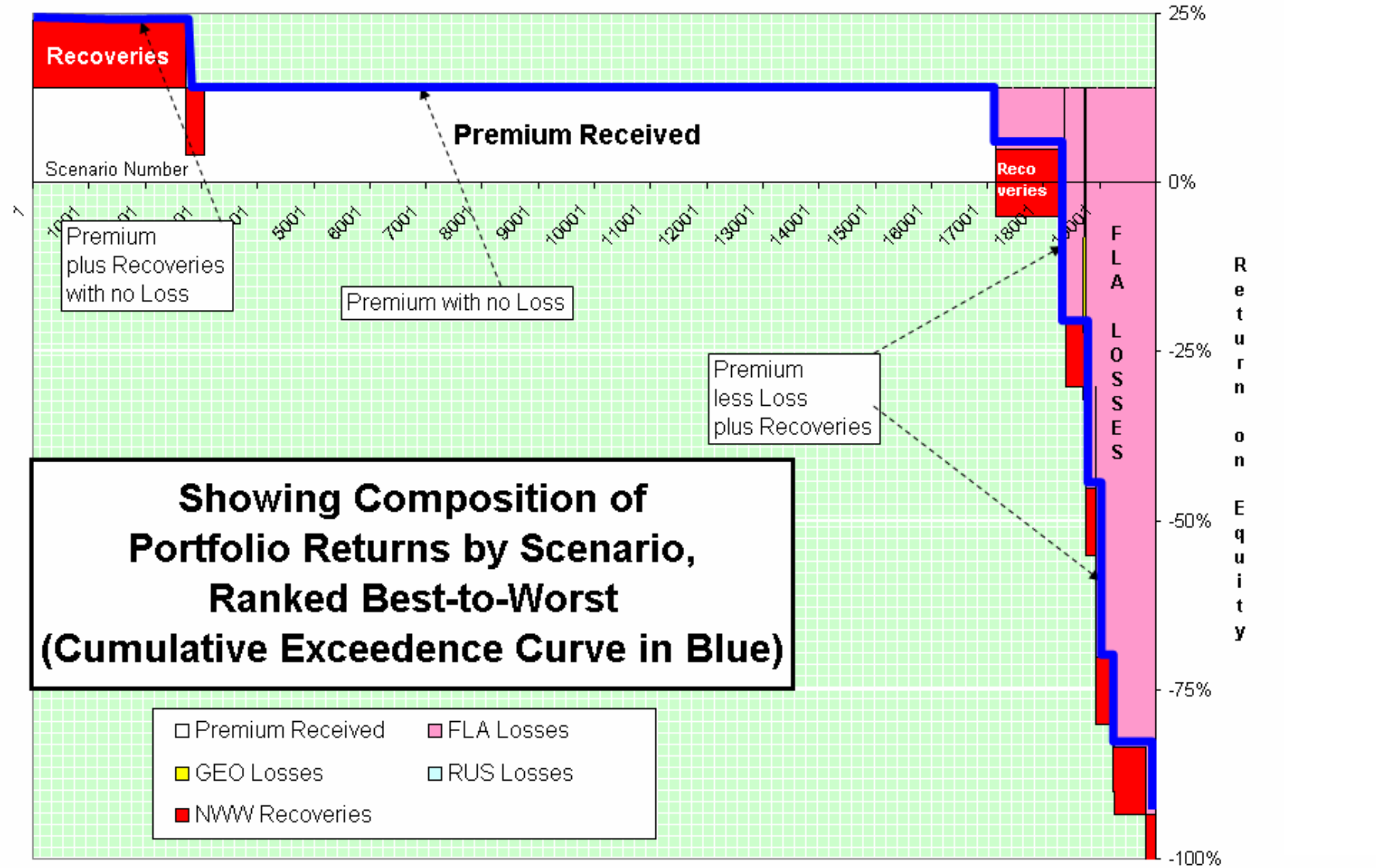
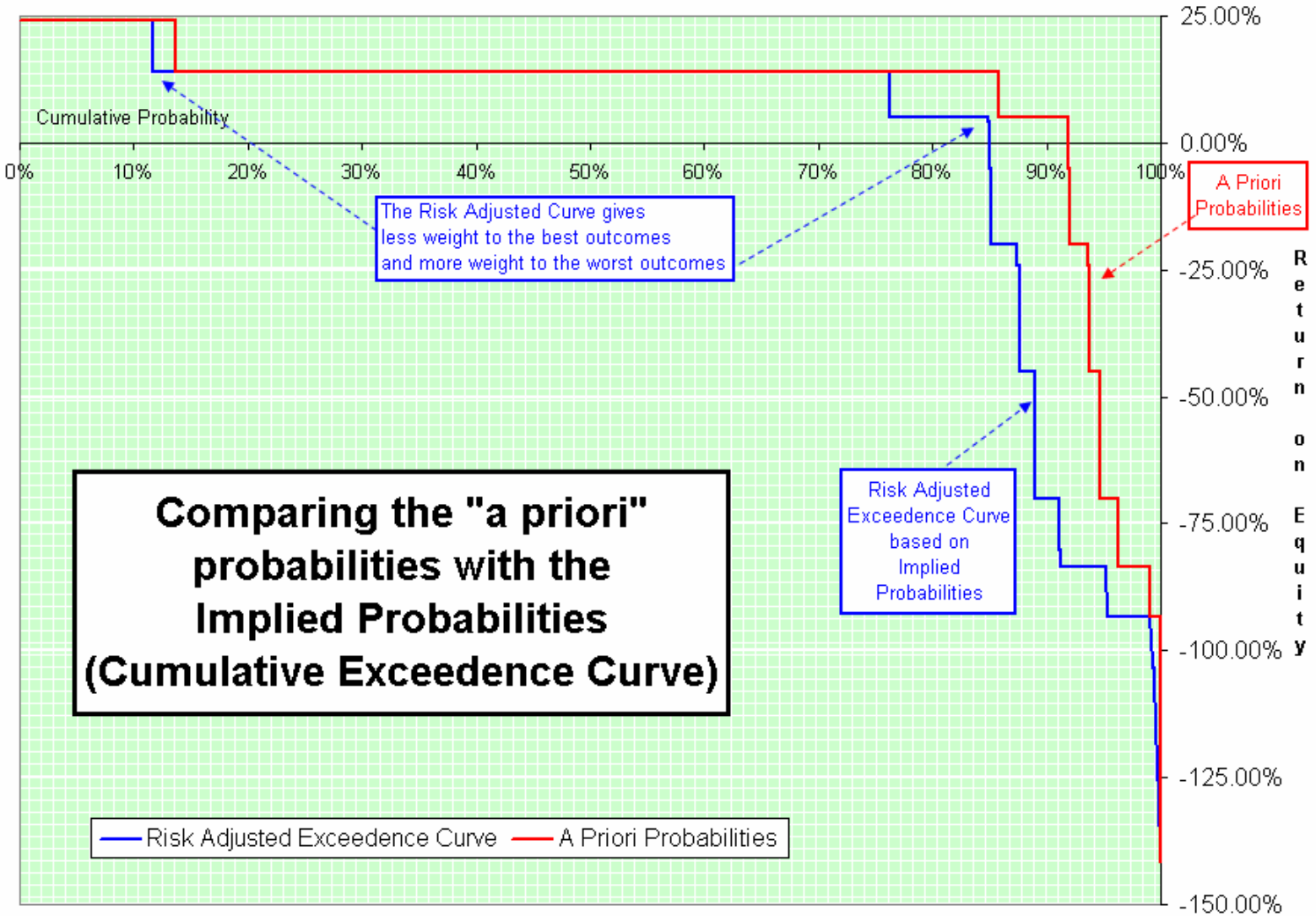

Cumulative Probability
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
25.00%
0.00%
-25.00%
-50.00%
-75.00%
-100.00%
Return on Equity
Portfolio Cumulative Exceedence Curve
- Three Zone Model
Optimum Curve with Risk Preference Constraints
A Priori Probabilities


Premium Received
Scenario Number
1001
2001
3001
4001
5001
6001
7001
8001
9001
10001
11001
12001
13001
14001
15001
16001
17001
Premium with no Loss
Premium
less Loss
FLA LOSSES
25%
0%
-25%
-50%
-75%
-100%
Return on Equity
Showing Composition of
Portfolio Returns by Scenario,
Ranked Best-to-Worst
(Cumulative Exceedence Curve in Blue)
Premium Received
FLA Losses
GEO Losses
RUS Losses


Recoveries
Premium Received
Scenario Number
Premium plus Recoveries with no Loss
Premium with no Loss
Premium less Loss plus Recoveries
Reco veries
FLA LOSSES
25%
0%
-25%
-50%
-75%
-100%
Return on Equity
Showing Composition of Portfolio Returns by Scenario, Ranked Best-to-Worst (Cumulative Exceedence Curve in Blue)
Premium Received
FLA Losses
GEO Losses
RUS Losses
NWW Recoveries


25.00%
0.00%
-25.00%
-50.00%
-75.00%
-100.00%
-125.00%
-150.00%
Return on Equity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Cumulative Probability
The Risk Adjusted Curve gives less weight to the best outcomes and more weight to the worst outcomes
A Priori Probabilities
Risk Adjusted Exceedence Curve based on Implied Probabilities
Comparing the "a priori" probabilities with the Implied Probabilities (Cumulative Exceedence Curve)
Risk Adjusted Exceedence Curve
A Priori Probabilities

How should Retro Premium Be Allocated ?

OPTIMAL PORTFOLIO COMPOSITION BY ZONE

(Expected returns calculated using original sample probabilities)

	FLA	GEO	RUS	NWW	TOTAL
Premium by zone	$18.02	$0.78	$0.20	-$2.80	$16.20
Transaction cost	$1.80	$0.08	$0.02	$0.28	$2.18
Net premium by zone	$16.21	$0.70	$0.18	-$3.08	$14.02
a priori Expected losses by zone	$8.08	$0.21	$0.10	-$2.95	$5.44
a priori Expected profit by zone	$8.14	$0.50	$0.08	-$0.13	$8.58
OR					
a priori Expected recoveries by zone	$1.31	$0.64	$1.00		
Allocating premium (by Exp. Recoveries)	$1.37	$0.66	$1.05		
Expected profit net of recoveries	$8.08	$0.47	$0.03		$8.58

How should Retro Premium Be Allocated ?

OPTIMAL PORTFOLIO COMPOSITION BY ZONE (Risk Adjusted Basis)

(Risk adjusted expected amounts use the implied probability vector)

	FLA	GEO	RUS	NWW	TOTAL
Premium by zone	$18.02	$0.78	$0.20	-$2.80	$16.20
Transaction cost	$1.80	$0.08	$0.02	$0.28	$2.18
Net premium by zone	$16.21	$0.70	$0.18	-$3.08	$14.02
Risk Adjusted Expected losses by zone	$15.43	$0.60	$0.18	-$3.72	$12.49
Risk Adjusted Expected profit by zone	$0.78	$0.11	$0.00	$0.64	$1.53
OR					
Risk Adj. Expected recoveries by zone	$2.14	$0.64	$0.95		
Allocating premium (by RAERecoveries)	$1.77	$0.53	$0.78		
Expected profit net of recoveries	$1.15	$0.22	$0.16		$1.53

How should Retro Premium Be Allocated ?

Allocating Retrocessional Premium to Zones

	FLA	GEO	RUS	Retro Cost
Proportionate to Exp. Loss	44%	22%	34%	$3.08
Proportionate to Risk Adj. Exp. Loss	57%	17%	25%	$3.08

Allocating Capital

		FLA	GEO	RUS	NWW	Premium		DUAL
Worst 20% of Scenarios								
A Priori	20.0%							
Expected Loss		$40.37	$0.69	$0.12	$7.17	$14.02	-20%	**0.67**
EL Allocation of Retro		$0.98	$0.02	$0.00				
		$39.39	$0.67	$0.12				
		98.0%	1.7%	0.3%				
Worst 0.1% of Scenarios								
A Priori	0.1%							
Expected Loss		$115.38	$7.85	$0.48	$10.00	$14.02	-100%	**41.09**
EL Allocation of Retro		$0.93	$0.06	$0.00				
		$114.45	$7.79	$0.47				
		93.3%	6.3%	0.4%				
Absolute Worst Scenario								
Maximum		$117.44	$48.30	$10.00	$10.00	$14.02	-141.72%	
		$0.67	$0.27	$0.06				
		$116.77	$48.03	$9.94				
		66.8%	27.5%	5.7%				

Allocating Capital

		FLA	GEO	RUS	NWW	Premium		DUAL
Worst 20% of Scenarios								
Implied on worst 20%	28.6%							
Risk Adj. Expected Loss		$53.87	$1.79	$0.31	$8.32	$14.02	-34%	**0.67**
RAEL Allocation of Retro		$0.96	$0.03	$0.01				
		$52.91	$1.75	$0.30				
		96.3%	3.2%	0.6%				
Worst 0.1% of Scenarios								
Implied on worst 0.1%	1.0%							
Risk Adj. Expected Loss		$109.74	$29.32	$1.78	$10.00	$14.02	-117%	**41.09**
RAEL Allocation of Retro		$0.78	$0.21	$0.01				
		$108.96	$29.11	$1.77				
		77.9%	20.8%	1.3%				
Absolute Worst Scenario								
Maximum		$117.44	$48.30	$10.00	$10.00	$14.02	-141.72%	-
		$0.67	$0.27	$0.06				
		$116.77	$48.03	$9.94				
		66.8%	27.5%	5.7%				

Allocating Capital

	Realtive Dual Value	
20% Dual	0.67	1.6%
0.1% Dual	41.09	98.4%
	41.76	100.0%

Allocating Capital

	FLA	GEO	RUS	NWW	Premium	DUAL
Risk Adjusted Capital Allocation	79.5%	20.9%	1.3%			
RACA Dollar Basis	$79.5	$20.9	$1.3			

END

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