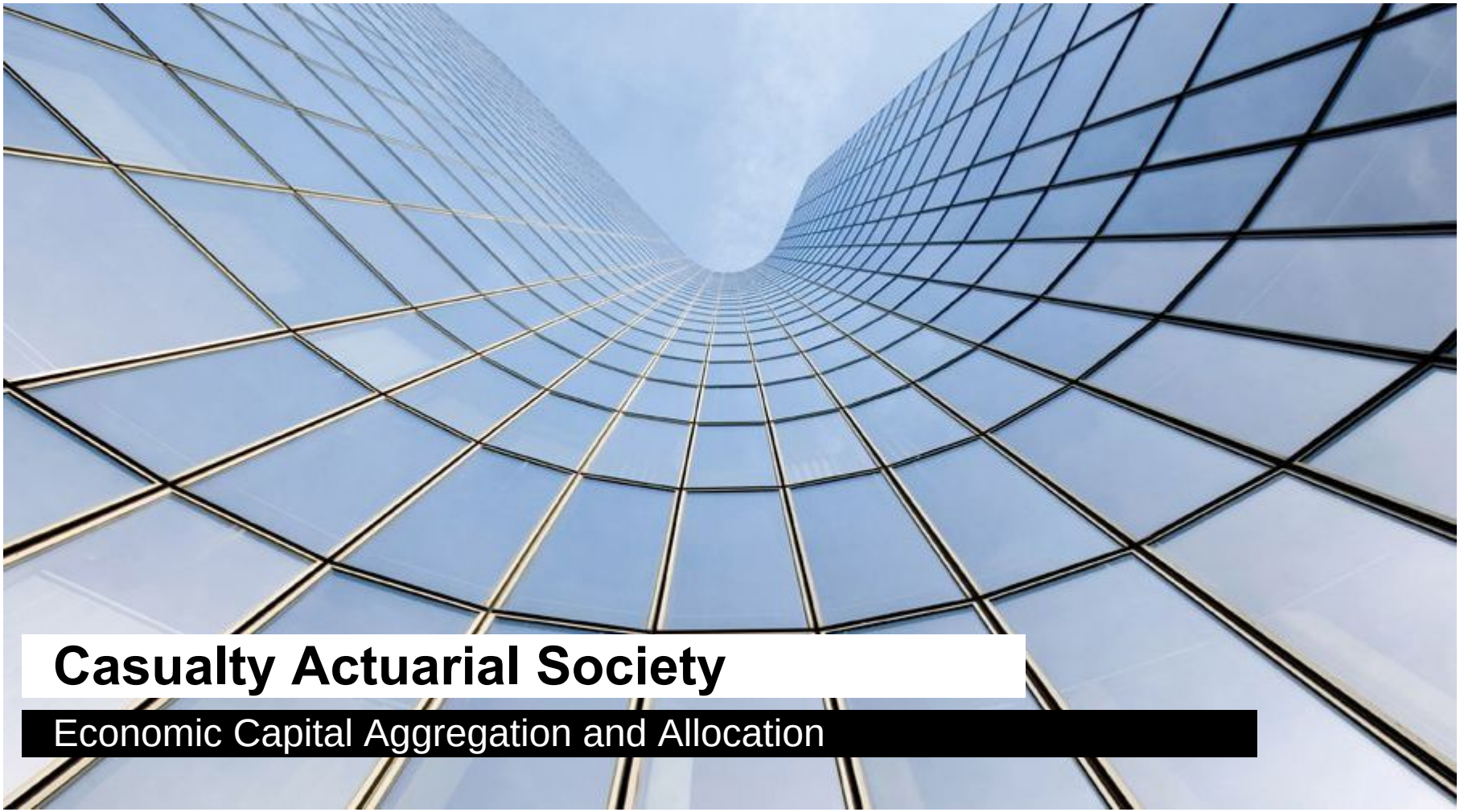


Casualty Actuarial Society

Economic Capital Aggregation and Allocation

By Thomas S. McIntyre, FCAS, CERA, MAAA

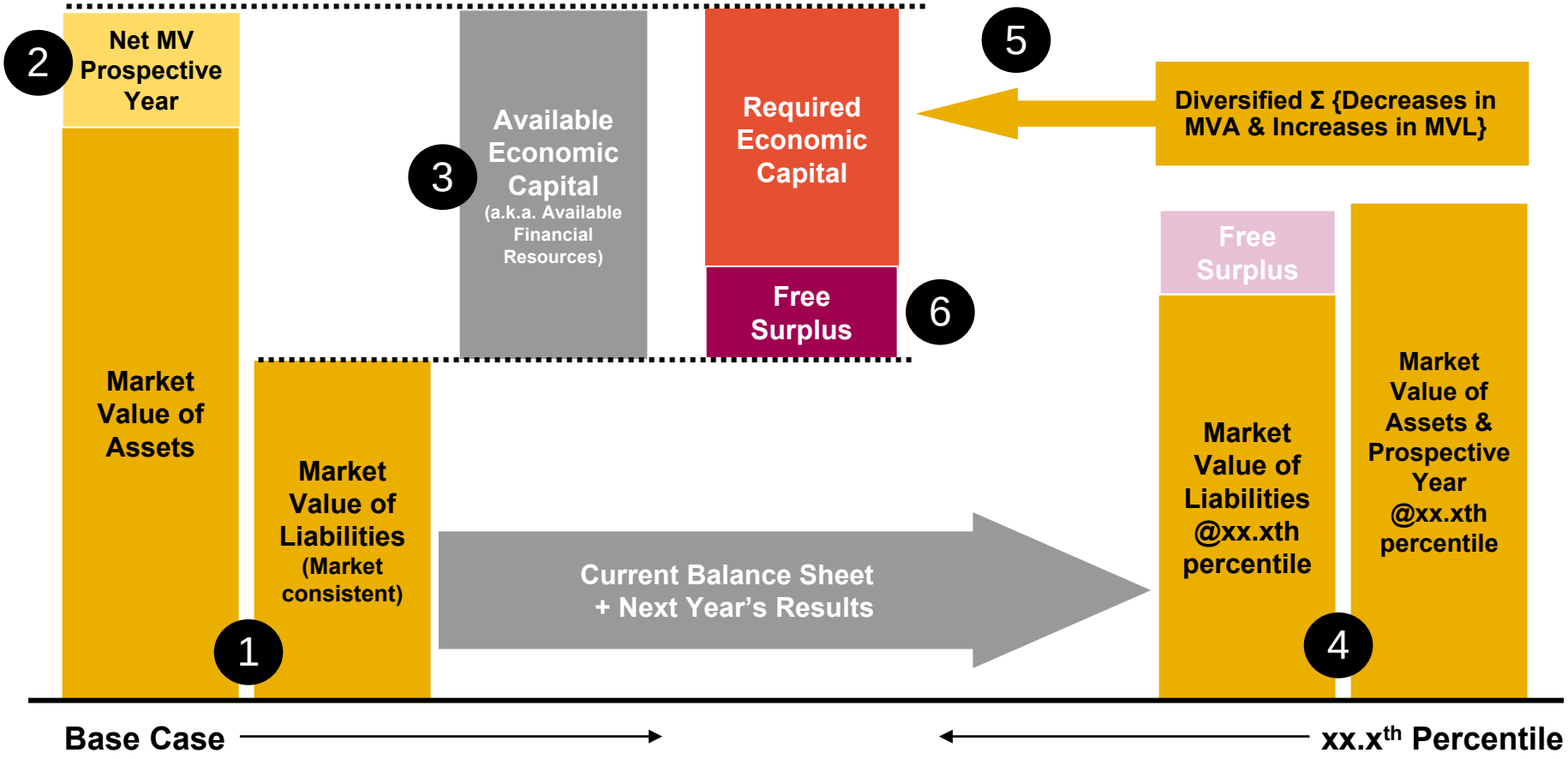
June 15, 2010

TOWERS WATSON

Agenda

- Introduction to economic capital
- Two brief cases studies
  - One year balance sheet-to-balance sheet risk aggregation
  - Economic capital within a Dynamic Financial Analysis (DFA) model
  - Pros/Cons
- Risk appetite

Definition of Economic Capital



- The one year aggregation process follows this balance sheet-to-balance sheet approach.
- DFA or run-off methods seek the same results but capture the prospective business by modeling earnings rather than adjusting the initial balance sheet.
- In either case, the capital "consumed" at the selected percentile defines the required economic capital

Economic Capital Aggregation

Some companies are using one-year market consistent aggregation methods to evaluation required economic capital. These methods are sometimes call “balance sheet-to-balance sheet” analysis.

The Economic Balance Sheet

- All assets are marked to market values
- All liabilities are carried at market consistent values
  - Market consistent value = NPV of best estimate plus a “market value margin”
- The present value of one year of new business is included on the starting balance sheet
- The examples herein ignore taxes
- Carried economic capital is sometimes called “available financial resources” or “AFR”

Market Value Margin

- Consider a buyer’s perspective on loss portfolio transfer (LPT)
- Best estimate (nominal) = $1million
- Best estimate (net present value) = $800,000

- The buyer must hold capital on its balance sheet if they are to assume the liabilities.
- The buyer requires a return on that capital that must be added to the price.
- So for example if the LPT price is $850,000, MVM is $50,000.

(See Philbrick – “Accounting for Risk Margins” CAS Forum 1994 and/or CRO Forum – “Market Value of Liabilities for Insurance Firms” July 2008 for additional discussion.)

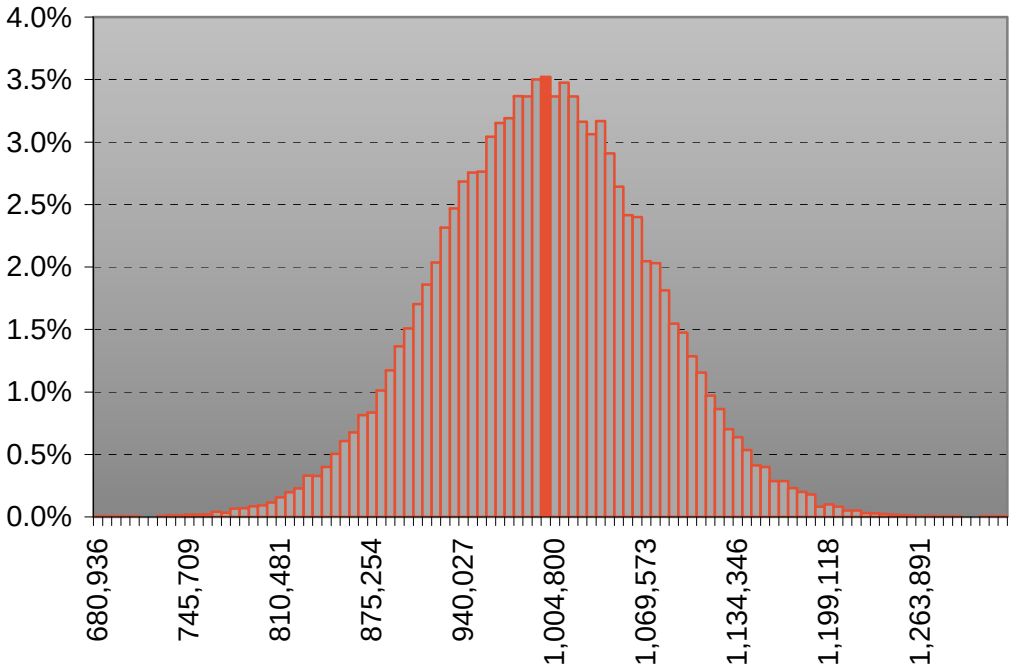
ABC Insurance Company – Economic Balance Sheet

- Investments - $1 million
- Loss reserves - $600,000 (w/MVM)
- New business - $135,000 (w/MVM)
  - NEP = $1.5 million
  - Loss Ratio = 70%
  - Discounted Loss Ratio = 63%
  - Expense Ratio = 28%
  - Expected Profit Margin = 9%
  - For simplicity, assume that the loss ratio includes the MVM
- Carried EC = $535,000

- Modeling assumptions:
  - Investments – Normal with a standard deviation of $75,000
  - Loss reserves – Normal with a standard deviation of $30,000
  - Losses on new business – Lognormal with a CV of 10%
  - The marginal distributions for assets and liabilities were restated to capture deviation from their mean value, i.e., contributions to profit/loss (a.k.a. required EC)
  - All distributions EC distributions were modeled as Normal with mean = $0.

Each “portfolio” has a distribution of expected results

PDF Charts



Risk Selection and Information

Risk	Investments

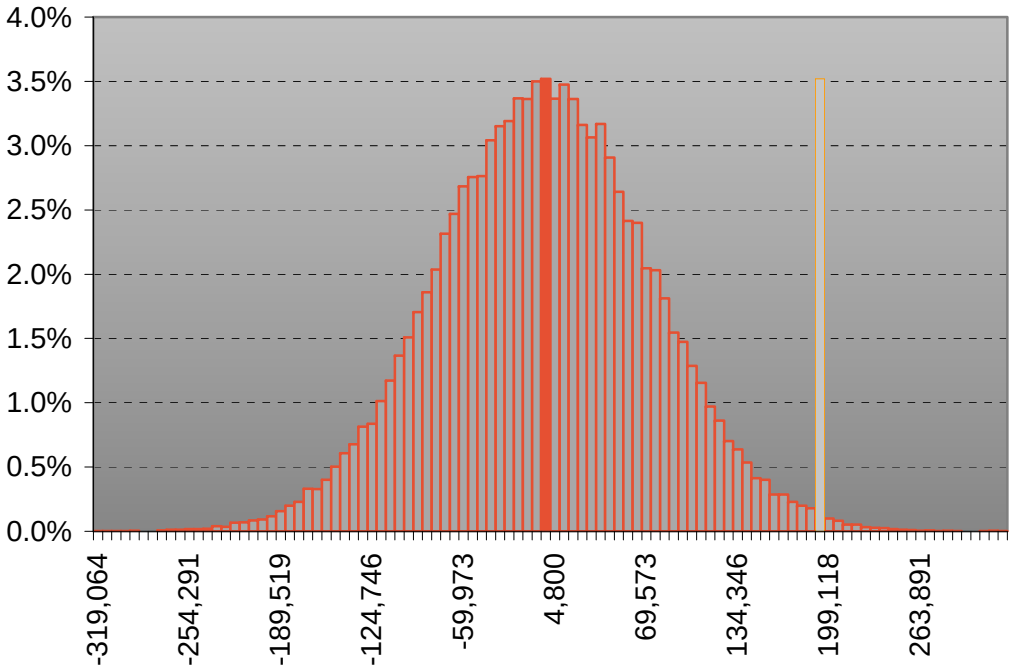
Mean	☑	1,000,155
StDev		75,092
Percentile	☐ 99.5%	1,194,859

Percentile	Value
0.5%	804,670
1.0%	824,452
10.0%	904,420
50.0%	1,000,233
90.0%	1,096,021
99.0%	1,176,600
99.5%	1,194,859

- Investments vary (mostly) between $900,000 and $1.1 million.
- Converting to contribution to profit/loss simplifies the aggregation of asset and liability risks

Restate each marginal distribution in terms of economic capital (change from the mean)

PDF Charts



Risk Selection and Information

Risk	Investments

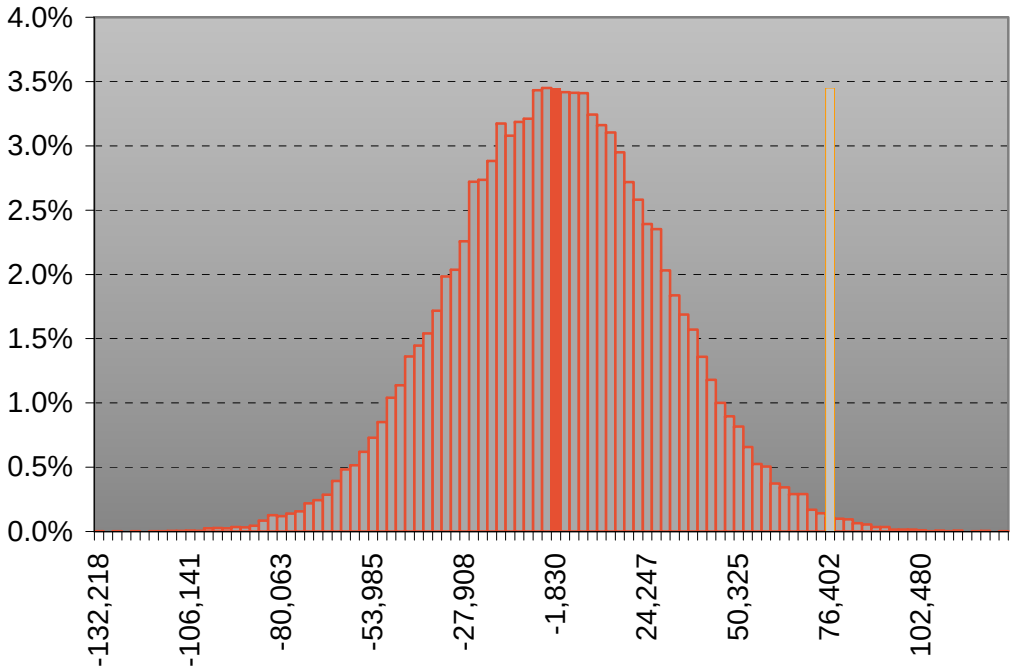
Mean	☑	155
StDev		75,092
Percentile	☑ 99.5%	194,859

Percentile		Value
0.5%	-	195,330
1.0%	-	175,548
10.0%	-	95,580
50.0%		233
90.0%		96,021
99.0%		176,600
99.5%		194,859

- Convert all marginal distributions to the distribution of their economic capital, i.e., an investment scenario below the mean consumes capital
- Positive values herein are increases in required EC (i.e., subtract simulations on prior page from the mean)
- Stand alone economic capital for investment risk at the 99.5% level is $194,859.

Loss reserve distribution

PDF Charts



Risk Selection and Information

Risk	Loss Reserves

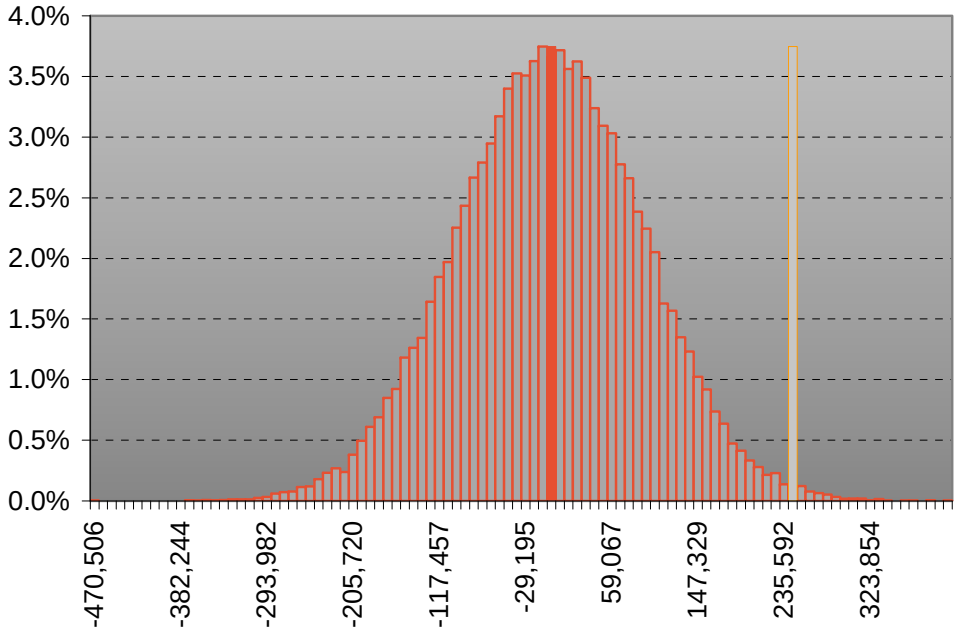
Mean	☑	- 2
StDev		30,079
Percentile	☑ 99.50%	77,950

Percentile	Value
0.5%	-78,417
1.0%	-70,307
10.0%	-38,660
50.0%	-20
90.0%	38,333
99.0%	70,118
99.5%	77,950

- Stand alone economic capital for reserve risk at the 99.5% level is $77,950.

New Business Loss Distribution

PDF Charts *Ver 1.1.146*



Risk Selection and Information

Risk	New Business

Mean	☑	35
StDev		95,040
Percentile	☑ 99.50%	248,062

Percentile	Value	Implied Loss Ratio
0.5%	-244,920	46.7%
1.0%	-222,516	48.2%
10.0%	-121,919	54.9%
50.0%	180	63.0%
90.0%	121,261	71.1%
99.0%	222,807	77.9%
99.5%	248,062	79.5%

- Expected losses are based on NEP = $1.5mm with a 63% loss ratio
- Contributions to required economic capital were modeled as a Normal distribution with mean = $0 and SD = $94,500
- Stand alone economic capital for new business risk at the 99.5% level is $248,062.

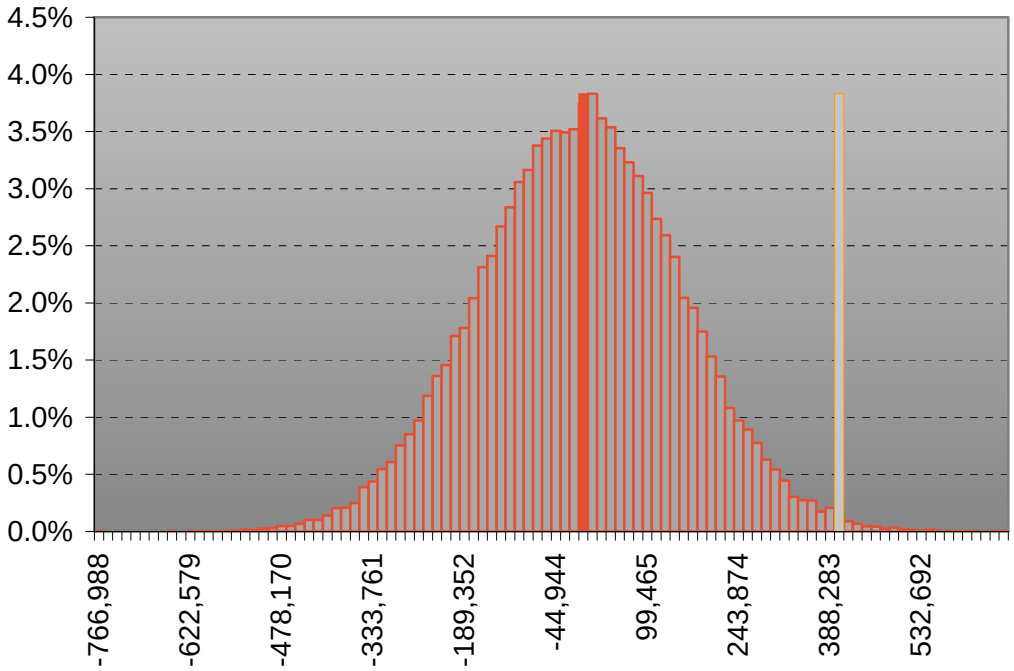
Correlation matrix

	Investments	Loss Reserves	New Business
Investments	**1.00**		
Loss Reserves	0.25	**1.00**	
New Business	0.25	0.75	**1.00**

- Marginal distributions were aggregated using a Gaussian copula and the selected correlation matrix.

Aggregate Economic Capital Distribution

PDF Charts



Risk Selection and Information

Risk	Total

Mean	☑	202
StDev		157,203
Percentile	☑ 99.50%	404,209

Percentile	Value
0.5%	-403,426
1.0%	-364,388
10.0%	-202,435
50.0%	1,652
90.0%	200,345
99.0%	368,927
99.5%	404,209

- At the 99.5% or “1-in-200 year” level, the company would “consume” $404,209 of capital.

Capital Allocation

Risk Diversification Aumann-Shapley Allocation

Simulation Range	5

Simulation	Sim Index	Investments	Loss Reserve	New Busines	Total
5863	-5	73,346	62,192	267,559	403,097
4278	-4	90,767	69,457	242,997	403,221
4987	-3	144,214	52,590	206,457	403,261
38018	-2	155,639	50,523	197,602	403,763
38603	-1	91,216	38,759	274,204	404,179
37094	0	32,294	53,888	318,025	404,207
39591	1	175,677	36,741	192,053	404,471
41165	2	113,766	81,708	209,389	404,863
7394	3	66,232	89,985	248,700	404,917
38219	4	162,327	79,816	163,633	405,776
49769	5	148,508	59,409	198,209	406,126
Allocated Capital		**113,958**	**61,348**	**228,902**	**404,207**

- Capital allocations are based on a range of values centered on the 99.5th percentile.
- We ran 50,000 trials in this example.

Economic Capital Summary

Risk	Carried Capital	Stand Alone Capital (99.5%)	Diversified Capital (99.5%)
Investments	–	$194,859	$113,958
Loss Reserves	–	77,950	61,348
New Business	–	248,062	228,902
Total	$535,000	$520,871	$404,207

- The fully diversified required economic capital of ABC Insurance at the 99.5th percentile is $404,207.
- The total diversification benefit is $116,664.
- The firm has $130,793 of excess capital at the 99.5th percentile level.

Economic Capital Analysis with DFA

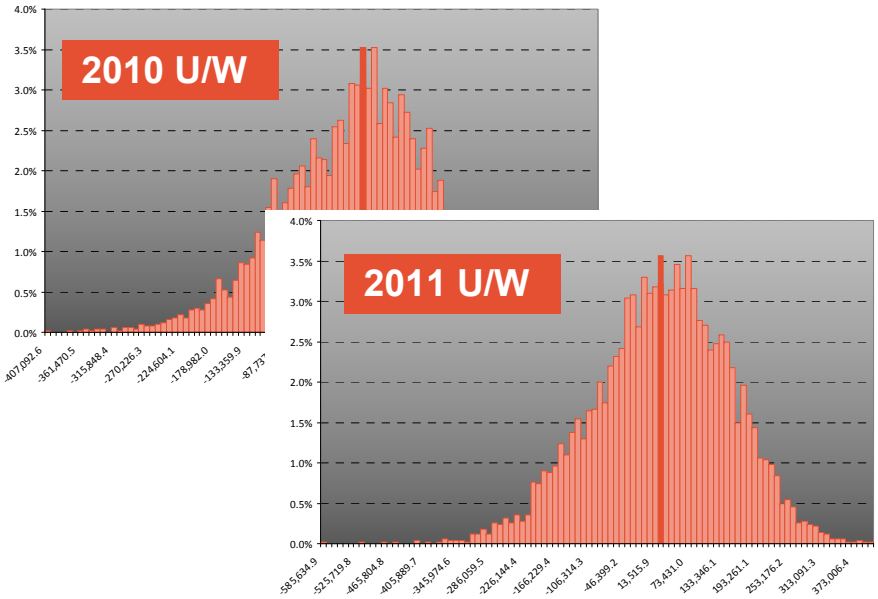
Many P/C insurers are turning to dynamic financial analysis (DFA) models to evaluate their required economic capital. Approaches vary but often include one to three years of new business and a run-off of the associated liabilities.

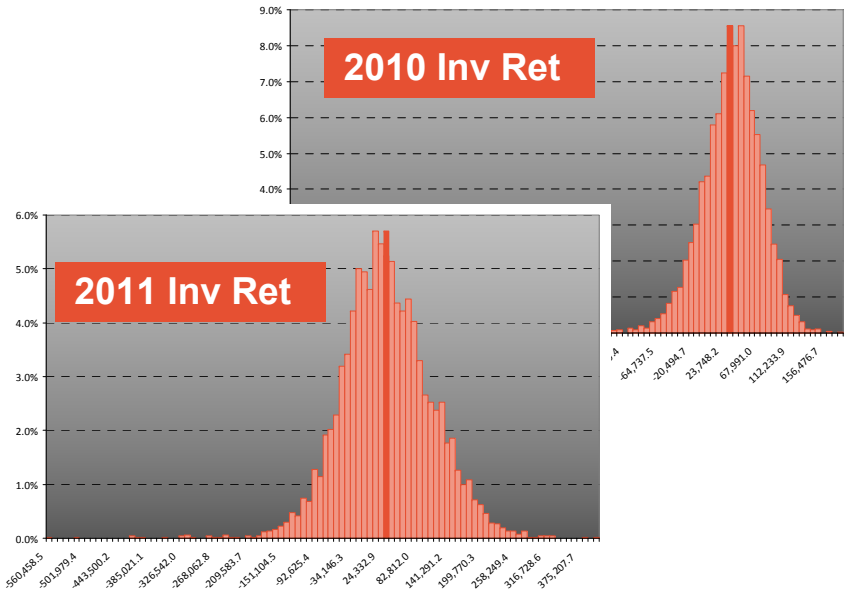
ABC Insurance Company

- Investments - $1 million
- Loss reserves - $600,000
- New business
  - NEP = $1.5 million
  - Loss Ratio = 70%
  - Expense Ratio = 28%

- Modeling assumptions:
  - Investments – 5 year corporate bonds
  - Loss reserves – Normal with a standard deviation of $30,000
  - Losses on new business – Lognormal with a CV of 10%
  - **Two years of new business were included**

Risk aggregation with DFA





- The DFA model aggregates insurance and investment operations to forecast profit/(loss)
- Economic capital is held to cover potential losses

Distribution of profit/(loss)

Probability Distributions *ver 3.1.100*

Workspace	C:\Documents and Settings\mcintyt\My Documents\2010 CAS EC Webinar\Simulum Models >>
Results	Run_08
Postpone	
Refresh	

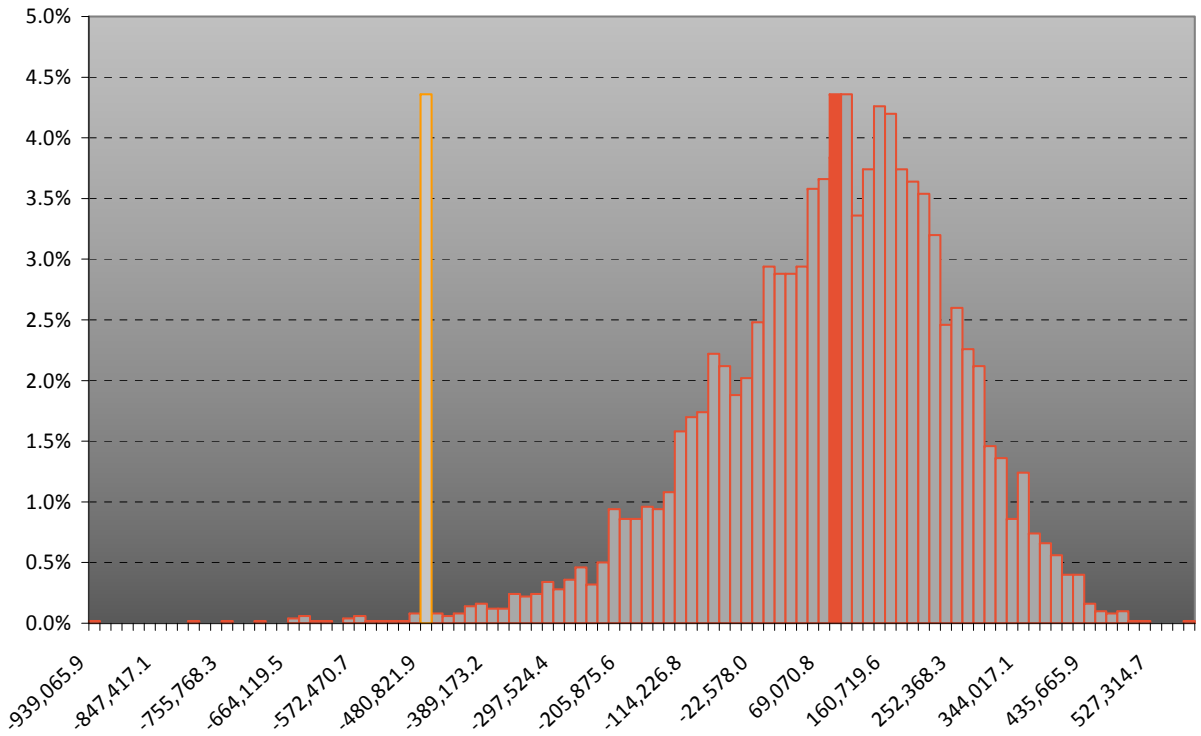
Chart Parameters

Origin	2011
Variable	Profit
Level	Net
Class	ABC
Percentile	0.50
Cumulative	☑
Sim	3,750

Summary

Mean	☑	87,987.5
StDev		168,716.5
Percentile	☑	-466,630.7

TVaR (plus)	91,461.2
TVaR (minus)	-598,017.3



- We focus on scenarios with losses, i.e., where capital is consumed.

Required economic capital is based on cumulative profit (losses)

- Profits for all projection years are calculated.
- Cumulative profit is measured through the end of each projection year.
- Select the minimum cumulative position throughout the projection period. If this is greater than zero then set to zero.
- The results of this process are then sorted across all simulations, VaR capital is then calculated simply by picking the nth smallest simulation.

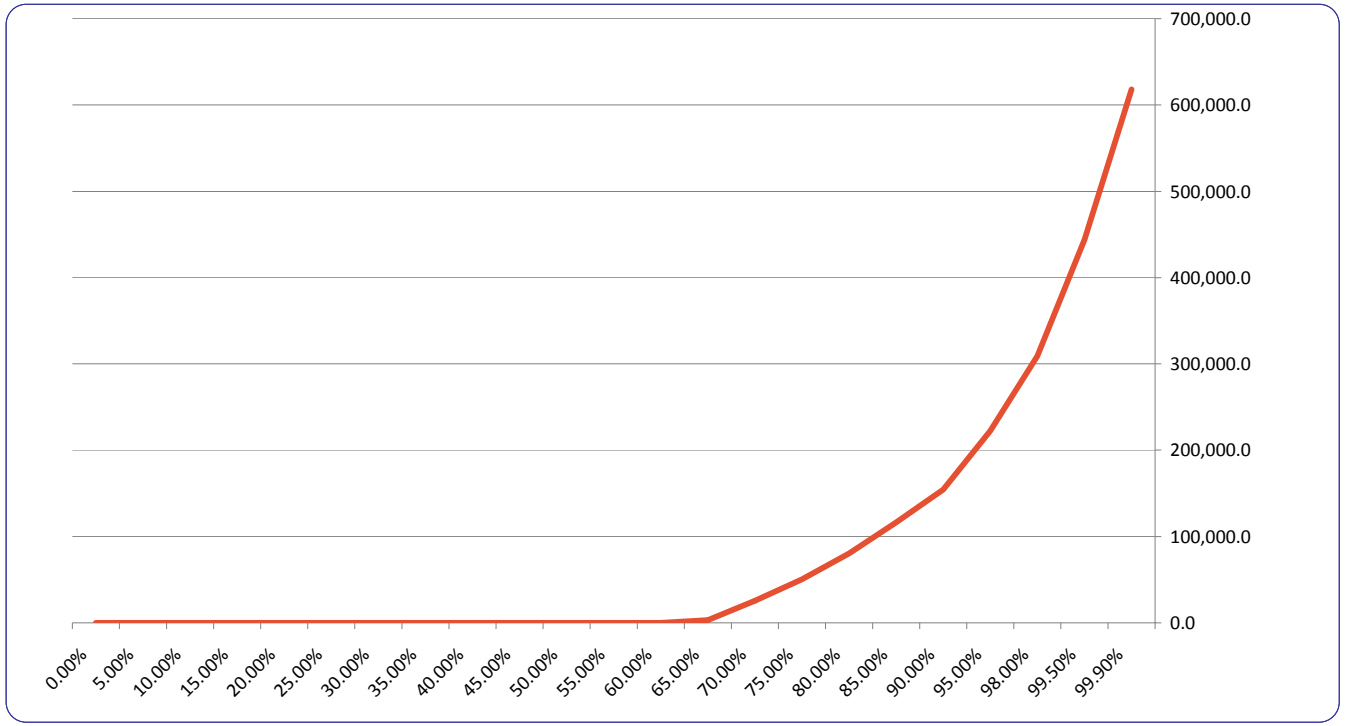
Economic Capital

Simulum Capital *ver 3.1.100*

Workspace	C:\Documents and Settings\mcintyt\My Documents\2010 CAS EC Webinar\Simulum Models
Run Number	Run_08
Ent/Lob	ABC
Gross/Net	Net
Risk	Insurance Profit
Last Origin	2011
Allow FY Profits	☑
Discount	☐

Recalc

Percentiles	Amount
99.90%	618,268.0
99.50%	444,002.4
98.00%	309,061.9
95.00%	222,380.7
90.00%	154,585.6
85.00%	116,450.2
80.00%	80,441.4
75.00%	50,350.7
70.00%	25,702.8
65.00%	3,132.7
60.00%	0.0
55.00%	0.0
50.00%	0.0
45.00%	0.0
40.00%	0.0
35.00%	0.0
30.00%	0.0
25.00%	0.0
20.00%	0.0
15.00%	0.0
10.00%	0.0
5.00%	0.0
0.00%	0.0



- Two year projection through year end 2011, most scenarios are profitable
- Tail scenarios consume capital significant capital

Pros/Cons of One-year Aggregation versus Run-off

One-year/Aggregation

- **Advantages:**
  - Easier to combine life and p/c capital
  - Speed
  - Consistent with year-to-year solvency monitoring/financial statement analysis
- **Disadvantages:**
  - Relatively new to US P/C insurers
  - Resistance to closed form distributions

DFA/Run-off Analysis

- **Advantages:**
  - GAAP and/or statutory metrics
  - Calculate rating agency capital ratios
- **Disadvantages:**
  - Some DFA models are quite complex
  - Extended run times for large jobs

Risk Appetite

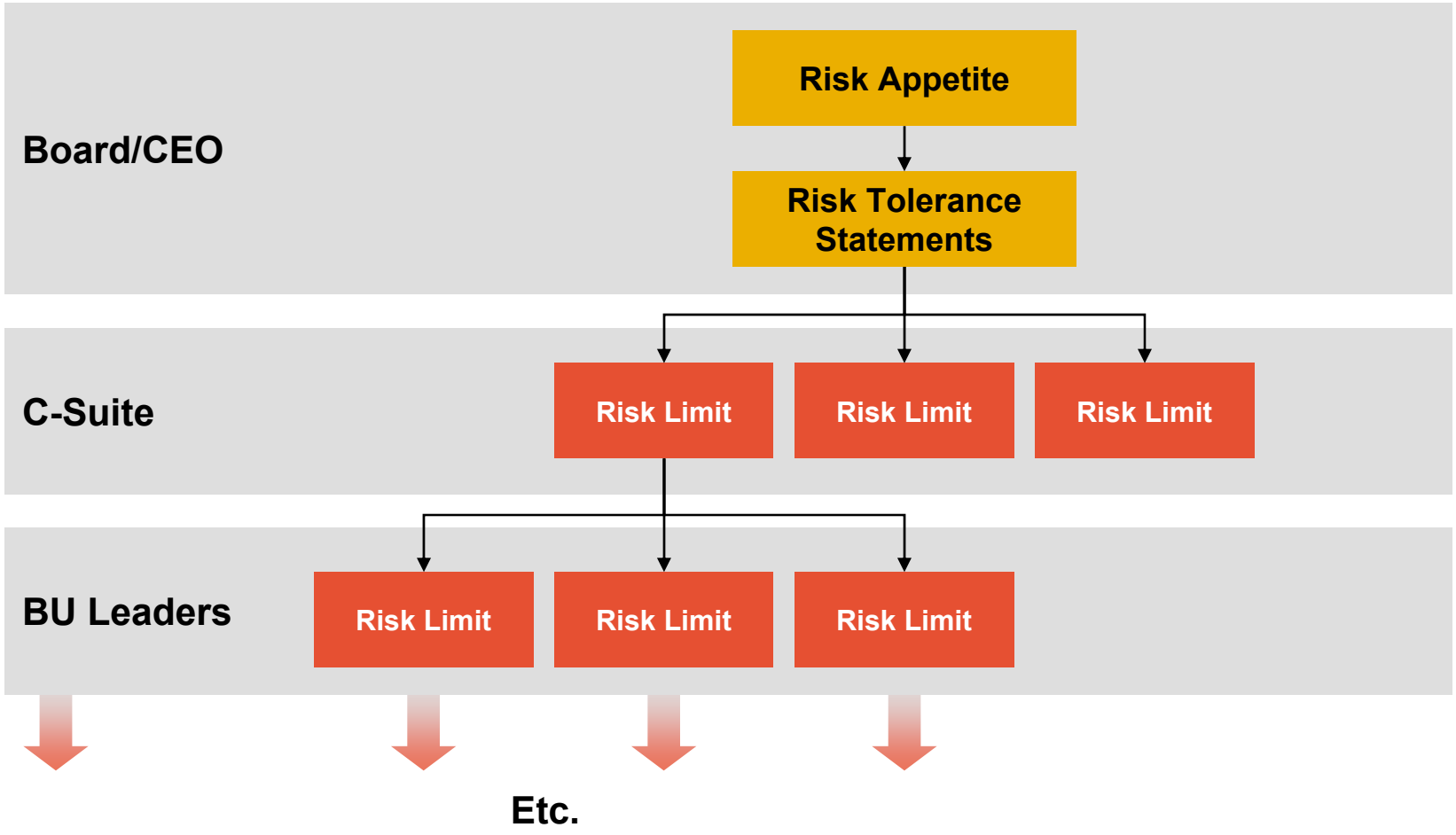
A brief introduction to risk appetite with an emphasis on the linkage between risk tolerances and economic capital modeling.

There is an implied "contract" between the board and management on risk and return

Board of Directors		Management
• Sets/approves overall risk appetite and corporate risk tolerance ◦ Aligned with shareholder expectations • Approves capital and business plans • Ensures appropriate corporate risk governance	**"Risk Contract"**	• Develops business strategy, sets financial targets (e.g., growth, earnings, ROE) • Determines overall (economic) capital needs and performs capital budgeting • Manages business to achieve results according to business plans and agreed risk tolerances

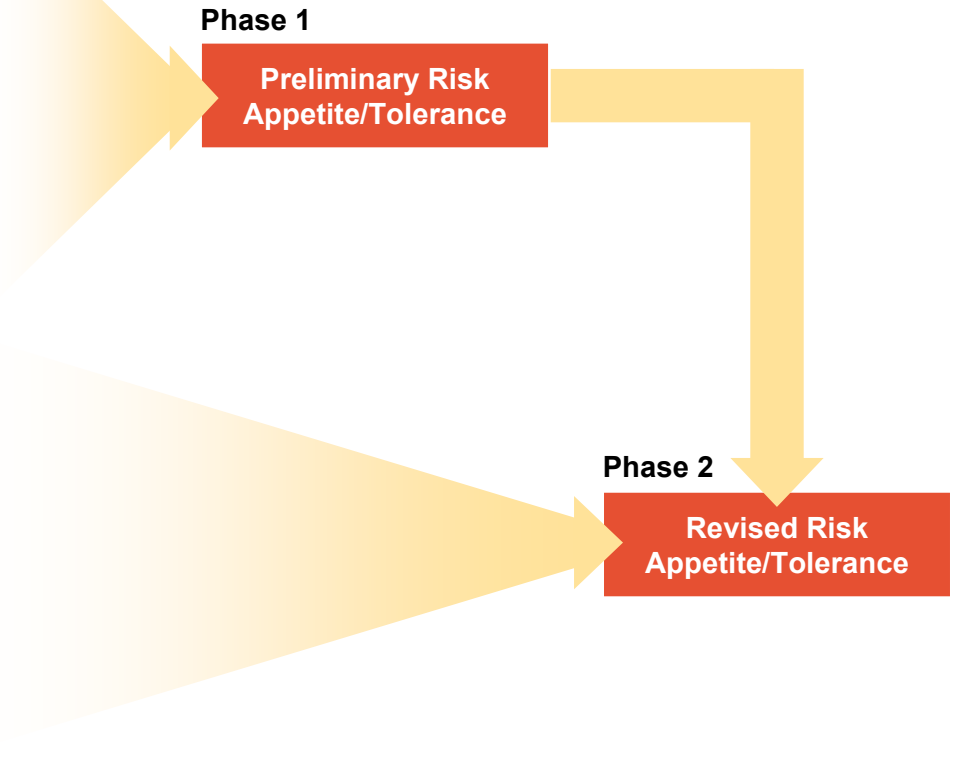
- Risk appetite aims to provide a framework for managing risk in the business
  - Risk appetite is defined formally by the board to provide guidance/principles to management
  - Provides a means of communicating the board's views and expectations on risk
  - Informs external audiences, including shareholders, bondholders, rating agencies, regulators
  - Informs internal audiences – decision makers at all levels

More granular expectations can be defined once the board and management agree on overall objectives



An approach to defining a company's Risk Appetite/Risk Tolerance

Qualitative	Quantitative	Inputs
✓		Company's Mission, Vision, & Values
✓		Management and BOD Perspectives
	✓	Industry/Company Historical Reference Points
	✓	Company's Risk Modeling and Sensitivity Testing
✓	✓	Regulatory/Rating Agency Thresholds
✓		Board Review and Input



Sample Risk Tolerance

	Review annually	Model quarterly and/or on demand	
Risk	**Risk Tolerance** (1:20 year hit to capital)	**Modeled Risk Position**	**Risk Dashboard**
Catastrophe Exposure	10%	7.3%	In compliance
Non-Cat Pricing Risk	12.5%	11.1%	Caution >80% of limit
Equity Risk	5%	6.2%	Risk position exceeds established limit
Interest Rate Risk	15%	6.7%	In compliance

- Risk tolerance is based on 1:20 rather than 1:2,000 year events
- Tolerances vary based on risk characteristics, e.g., higher limits for "paper losses" and/ or areas of competitive advantage