So Many Models – Part III
Critique of Capital Modeling Approaches

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AON

Agenda

Section 1	Drivers of Insurer Impairments & Insolvencies
Section 2	Effectiveness of Factor Based Models
Section 3	Effectiveness of Stochastic & Structural Models
Section 4	Capital Modeling – Realistic Agenda

Economic Capital Capital Adequacy

Solves dual problems

- Adequacy of current capital
- Capital required for given level of adequacy

Determined by a metric

- Premium to surplus
- RBC, BCAR, SPCAR, QIS III
- VaR, TVaR etc.

Requires analysis of full balance sheet

- Asset risk, regulatory risk
- Reserve risk, credit risk
- Competition risk, catastrophe risk

Capital Allocation

Determined by a method

- Marginal capital
- Equal risk VaR/TVaR
- Risk adjusted probability

Provides capital for return on allocated capital evaluation

- Pricing & ratemaking
- Compensation
- Evaluation of alternative business plans

Focuses on prospective business plan

- Return generating units
- Strategic planning and direction
- Sunk costs irrelevant – reserves
- Reserve leverage germane

Section 1

Drivers of Insurer Impairments & Insolvencies

Drivers of Impairments – Heuristic

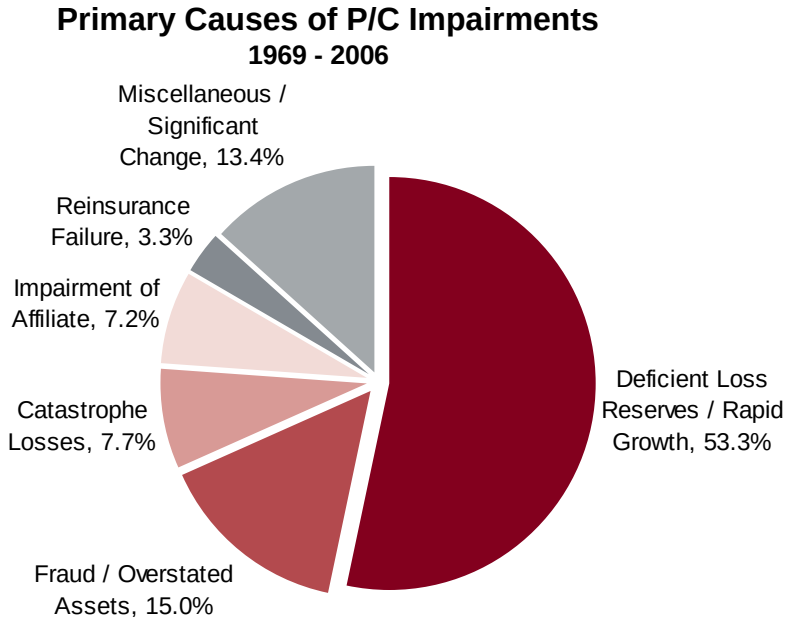
1987-present

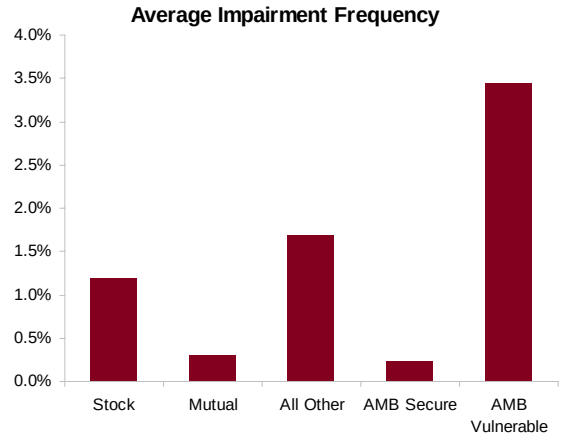
'87	Company	'05	Disposition
1	State Farm	1	
2	Allstate	3	
3	Aetna		sold P/C to Travelers
4	AIG	2	
5	Liberty Mutual	8	
6	Nationwide	6	
7	Hartford	10	
8	Farmers		bought by Zurich
9	Travelers	4	
10	CIGNA		sold P/C to ACE
11	CNA	13	sold pers/l (ALL); reins (WTM)
12	Continental		bought by CNA
13	USF&G		bought by St Paul
14	Crum & Forster		bought by Fairfax
15	Fireman's Fund		bought by Allianz
16	Chubb	11	
17	Kemper		in run off
18	St. Paul		bought by Travelers
19	Royal		in run off, bt.by mgmt, Arrow Point
20	USAA	12	
21	General Re		bought by Berkshire Hathaway
22	Lincoln National		sold P/C to Am States/Safeco
23	Home		bought by Zurich
24	Prudential		bought by Liberty Mutual
25	American General		bought by AIG
26	American Financial	33	= Great American
27	Transamerica		spun off to TIG (Fairfax)
28	Reliance		insolvent
29	Safeco	16	
30	GEICO		bought by Berkshire Hathaway
31	American Family	14	
32	General Accident		no longer in US P/C
33	Ohio Casualty		bought by Liberty Mutual
34	America		exited
35	Employers Re		bought by GE, Swiss Re
36	Zurich	17	
37	Motors	28	= GMAC
38	Progressive	7	
39	Commercial Union		bought by White Mountain
40	California State Auto A	34	
41	Sentry	42	
42	Associated Insurance		bought by Travelers
43	Auto Owners	21	
44	Erie Ins. Exch.	22	
45	PMA		under supervision
46	Interins Exch Auto Clu	>100	
47	Auto Club of MI	52	
48	Berkshire Hathaway	5	
49	Southern Farm Bureau	41	
50	Cincinnati Financial	24	
51	Munich Re	41	
52	Employers of TX	>100	
53	Swiss Re	18	
54	Metroplitan	25	now Met P&C
55	Old Republic	36	
56	Federated Mutual	59	
57	Ford Motor		sold?
58	Colonial Penn		run off / no longer in P&C
59	Nationale-Nederlander		no longer writing
60	Amica Mutual	53	
61	Atlantic Mutual	>100	Balboa partnership
62	Winterthur		bought by CSFB, XL
63	20th Century		rescued by AIG
64	Amerisure Companies	98	
65	Harleysville	57	
66	W. R. Berkely	19	
67	Orion Capital		bought by Royal
68	Teledyne		spun off into Unitrin
69	NJ Manufacturers	49	
70	Westfield	48	
71	Utica National	92	
72	John Hancock		no longer writing P&C
73	Foremost		bought by Farmers
74	State Auto Mutual	54	
75	Country Companies	39	
76	Selective	47	
77	Clarendon		bought by Hannover Re
78	American Mutual Liab	102	
79	Shelter Ins	64	
80	Mercury General	27	
81	Skandia America		Imploded
82	Employers Mutual Cas	60	= EMC
83	Zenith National	58	
84	California Casualty	>100	
85	Alfa	68	
86	ALLIED		bought by Nationwide
87	Argonaut	77	
88	Arkwright		merged with FM Global
89	Fremont		Calif WC, Unicover
90	Allendale		merged with FM Global
91	Medical Liab Mut (NY)	70	
92	Penn National	99	
93	Central Benefits Mutua		exited P/C
94	Hartford Steam Boiler		bought by AIG
95	Commercial Credit		
96	Grange Mutual	63	
97	SAIF	>100	Oregon state fund
98	American Bankers		bought by Assurant
99	Motorists Mutual	91	
100	Indiana Farm Bureau	100	

Drivers of Impairment – Factual

A.M. Best Impairment Study

Cause (1969-2006)	Pct Total
Deficient Loss Reserves	37.6%
Rapid Growth	15.7%
Alleged Fraud	8.1%
Catastrophe Losses	7.7%
Impairment of Affiliate	7.2%
Overstated Assets	6.9%
Significant Change	4.4%
Reinsurance Failure	3.3%
Miscellaneous	9.0%





- 658 impairments* in 38 year period 1977-2006
- Note low impairment rate for mutual companies
- Consistent with higher survival rate on previous slide
- Premium weighted impairment rates lower

Source: A. M. Best Impairment Study, 2007
* A. M. Best defines impairment as restrictive regulatory action

Section 2

Effectiveness of Factor Based Models

Effectiveness of Factor Based Models

- Insolvency Experience, Risk-Based Capital and Prompt Corrective Action in Property-Liability Insurance, by Cummins, Harrington, Klein (1995)

- Analysis of RBC data from 1989 to 1991 capturing failures through Q3 1993
  - Just prior to introduction of P&C RBC in March 1995

- Four main findings
  - Less than half of the companies that later failed had RBC ratios within the proposed RBC ranges for Regulatory or Company action level
  - However, total and component RBC ratios are generally significantly different for failed and surviving firms based on univariate tests
  - Logistic regression indicates that allowing the weights of RBC components to vary and including firm size (log-assets) and organizational form (mutual indicator) materially improved R^2 and tradeoff between Type I and II errors
  - RBC models are less successful in predicting large firm insolvencies than smaller insolvencies

Effectiveness of Factor Based Models

- Less than half of failed companies…
  - AMB shows less than 25% of companies rated A- or better 5 years prior to impairment
  - AMB used BCAR but ratings are not purely factor-based & include qualitative factors
- Vary weights by size
  - BCAR reserve and premium components do include size, growth and diversification
  - Some size adjustment in SP Enhanced CAR
  - QIS III in Europe also includes some size adjustments
  - Aon Re Insurance Risk Study indicates underwriting risk decreases with size but pricing cycle more severe for larger companies
  - Correlation risk increases with size and complexity

Impaired Companies in Each Rating Category By Years Before Impairment

U.S. life/health and property/casualty data from 1977 to 2006.

	<----- No. of Years Before Impairment ----->					In Year of
Rating Category	5 Years	4 Years	3 Years	2 Years	1 Year	Impairment
A++/A+	32	35	34	29	14	1
A/A-	132	126	132	110	58	10
B++/B+	122	126	110	115	90	25
B/B-	77	79	96	111	116	92
C++/C+	30	37	41	36	58	54
C/C-	16	16	16	24	48	62
D/NA-7	67	70	83	92	147	208
Not Formally Followed*	202	189	166	161	147	226
All	**678**	**678**	**678**	**678**	**678**	**678**

* The "Not Formally Followed" category represents companies that did not have a Best's FSR at the time period in question but had a Best's FSR at some time after Dec. 31, 1977.

Source: A.M. Best Co.

Ratings Prescience

Rating	Average	2 Years	1 Year	Year of
A's	69.3%	20.5%	10.6%	1.6%
A or B's	93.6%	53.8%	41.0%	18.9%

Factor based models have not reached state-of-the-art

BCAR & RBC Compared

- Capital Ratios and Property-Liability Insurer Insolvencies by Pottier and Sommer (2000)
  - Compares RBC with A.M. Best ratings
  - Key finding “Best’s CAR significantly outperforms the NAIC’s RBC ratio”
  - Combing RBC and BCAR provides no better predictive ability than BCAR alone
  - Suggests that BCAR is superior because of “qualitative adjustments made by expert analysis”
  - Also find that BCAR “provides incremental information not fully reflected in the rating”

- Reserve capital factor
  - Cummins, Harrington and Klein find reserve capital not predictive of impairment, unlike asset, premium and growth capital
  - Appears with wrong sign in regressions
  - Failure to differentiate good and bad loss development
  - Issue still plagues factor based models today

Section 3

Effectiveness of Stochastic & Structural Models

Garbage In, Garbage Out

"We rely heavily on [the company's] risk-management ability. You can't overemphasize how important that is. It's the underpinning to everything... It gives you a nice, warm, fuzzy feeling... Even though they're taking more risk, their market presence and risk-management skills allow them to get away with it... [They have] such extraordinary risk management capabilities that we look at them differently."

Credit Rating Analyst

Stochastic, "sophisticated" models more prone to GI-GO

Model Risk and Hubris, Deja Vu?

- October 1987 – Black Monday Stock Market Crash
- September 1998 – LTCM
- Fall 2001 – Enron
- September 2005 – Katrina
- August 2007 – Sub-prime Crisis

- Common Quotes
  - "Theoretically, the odds against such a loss had been prohibitive; such a debacle was, according to mathematicians, an event so freakish as to be unlikely to occur even once over the entire lifetime of the universe." 1998
  - "No company has a better handle on its enterprise risk than ___." 2001
  - "The odds of an event exactly like Katrina striking are less than 1 in 500." 2005
  - "Our risk models failed to pick up that we were due for a correction. We were highly diversified. It was the perfect negative storm." 2007
  - "[Company] said that its funds had been hit by moves that its models suggested were 25 standard deviations (1 in 10^{136} probability) away from normal." 2007

Prudent model adjustment: search & replace "year" by "day"?!

Bank Sub-prime Exposure vs. Reported Trading VaR

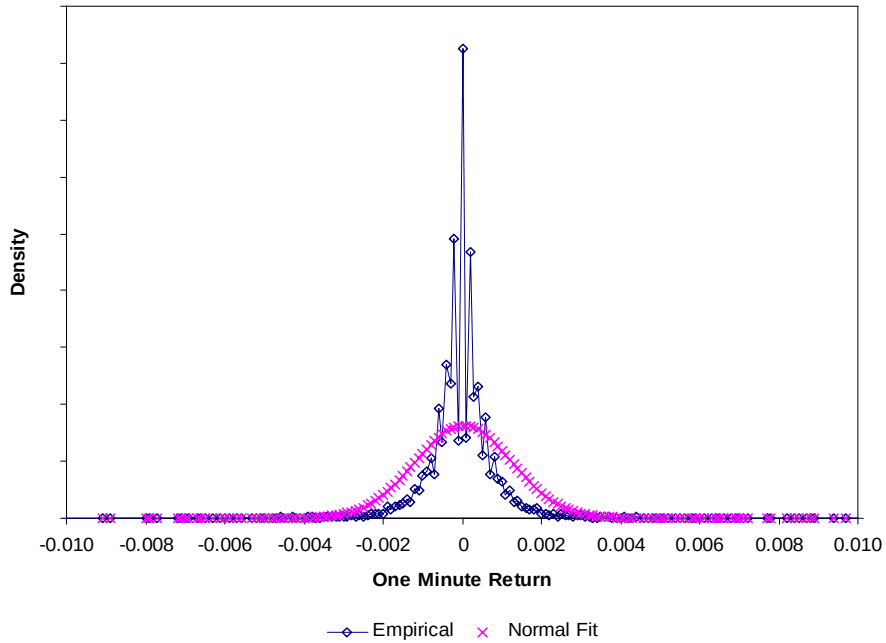
Company	Ticker Symbol	Total Equity Aug-07 (in billions $)	Average Qtrly Earnings (in billions $)	Total Assets Aug-07 (in billions $)	SubPrime Markdown (in billions $)	Reported VaR Metric (in billions $)	VaR Metric Description	Subprime Loss Relative to Reported VaR	SubPrime Loss % of Qtrly Earnings
Merril Lynch	MER	42.19	2.26	1,076.32	8.40	0.052	1 day, 95%	161.5 x	371.0%
UBS	UBS	41.21	3.47	2,042.08	3.40	0.139	1 day, 99%	24.4 x	98.1%
Citigroup	C	127.75	5.43	2,220.87	3.50	0.106	1 day, 99%	33.0 x	64.5%
Deutsche Bank	DB	47.25	1.68	2,523.52	3.10	0.100	1 day, 99%	31.0 x	184.7%
Morgan Stanley	MS	35.25	2.17	1,185.13	2.40	0.089	1 day, 95%	27.0 x	110.6%
Goldman Sachs	GS	39.12	2.63	1,045.78	1.70	0.101	1 day, 95%	16.8 x	64.7%
Lehman Brothers	LEH	21.13	1.05	605.86	0.70	0.042	1 day, 95%	16.7 x	67.0%
Bear Stearns	BSC	13.00	0.42	397.09	0.70	0.029	1 day, 95%	24.5 x	167.7%
Bank of America	BAC	135.51	5.08	1,578.76	1.45	0.041	1 day, 99%	35.1 x	28.6%

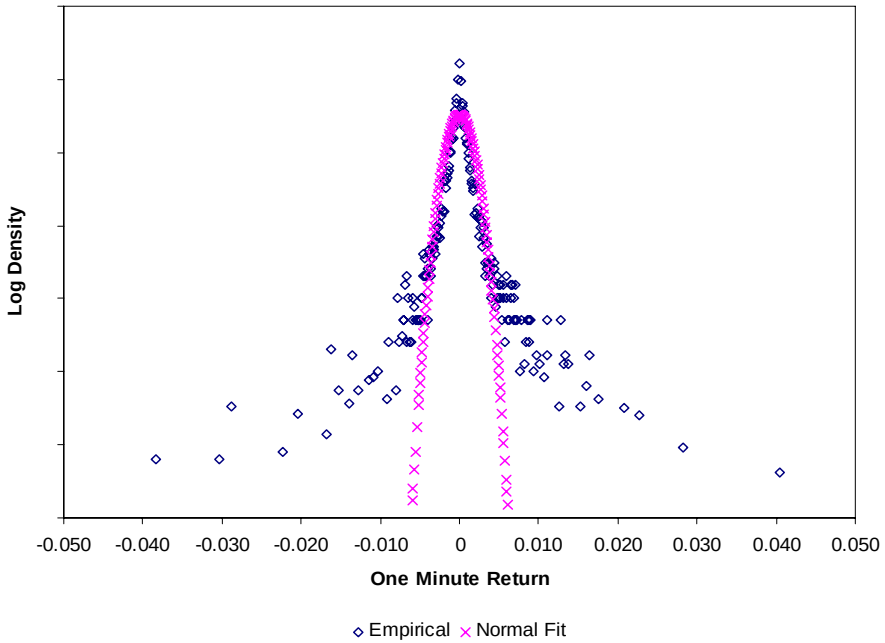
- Sub-prime markdowns substantially above reported “trading portfolio” VaR metrics
  - How does the average volatility relate to the volatility in stressed environments?
  - Does adverse outcome imply event was extreme, or that metric was flawed?
  - What is the relationship between a one day volatility and a firm’s ultimate risk?
- Models help us understand relative and comparative risk positions
- Models can provide insight into impact of change in assumption
- Absolute value of model output may be less useful
- Models must use good business sense to capture “unknown-unknowns”
  - Aon Re modeling attempts to capture full range of possible outcomes

History turns out consistently more risky than most models suggest

Reality vs. Conventional Wisdom

Stock Price Distribution Assumption





- Density of 1 minute returns not normally distributed
- Largest observed changes ±4%
  - Most big moves occurred late in trading day, between 15:10 and 15:20
  - For normal model ± 4% is a 1 in 10^{233} event
  - Actually occurred twice in 19,000 observations

Modeling Reserve Risk

Reserve Risk Study ($000)

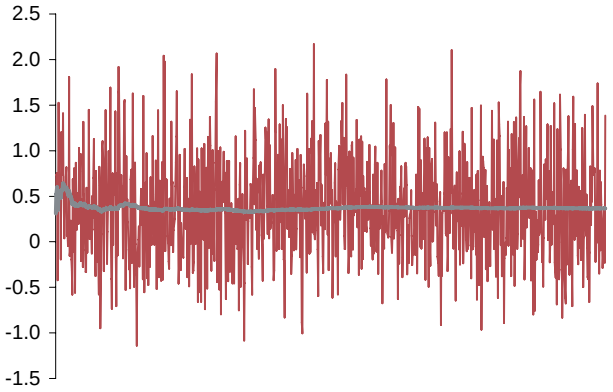
Company Name	XYZ Co.	Evaluation Date	12/31/2001
Line of Business	Other Liab - CM	Carried Reserve	**3,881,855**

Loss Development Triangle

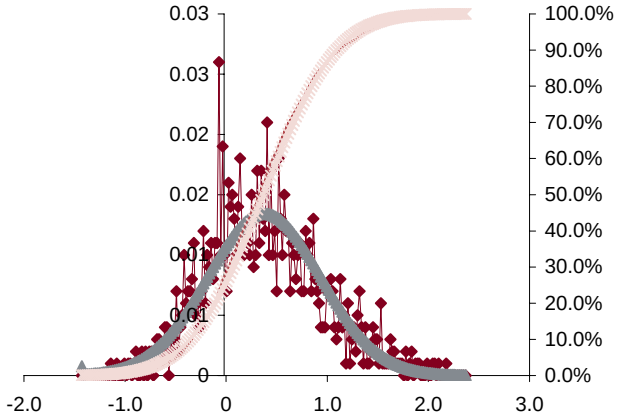
AY	1 : 2	2 : 3	3 : 4	4 : 5	5 : 6	6 : 7	7 : 8	8 : 9	9 : 10	Ult LR
1992	2.452	1.455	1.213	1.068	1.020	1.029	0.974	1.005	1.011	57.8%
1993	2.274	1.304	1.177	1.088	1.045	0.992	1.010	0.996		52.6%
1994	1.645	1.388	1.179	1.055	0.977	1.019	1.004			50.9%
1995	2.496	1.427	1.123	1.032	1.020	1.023				52.3%
1996	2.180	1.348	1.025	1.047	1.082					51.3%
1997	1.839	1.362	1.115	1.125						55.8%
1998	2.247	1.281	1.381							65.6%
1999	2.066	1.457								69.2%
2000	1.668									55.4%
2001										61.2%
Selected	1.970	1.375	1.176	1.069	1.029	1.017	0.996	1.001	1.011	1.002
FTU	3.590	1.823	1.326	1.128	1.055	1.026	1.009	1.013	1.013	1.002
Sigma	0.153	0.046	0.099	0.035	0.043	0.017	0.015	0.010	0.007	0.033

Simulation Statistics		**%ile**	**Lower**	**Current**	**Upper**	**Lower %**	**Upper %**
Average Development	366,970	10.0%	3,555,277	3,881,855	5,011,571	-8%	29%
Std Dev Development	565,763	5.0%	3,398,926	3,881,855	5,259,594	-12%	35%
SD / Carried	14.6%	2.0%	3,207,112	3,881,855	5,522,619	-17%	42%
Skewness	0.347	1.0%	3,083,578	3,881,855	5,690,906	-21%	47%
Kurtosis	-0.019	0.4%	2,934,006	3,881,855	5,860,468	-24%	51%

Simulation Spectral Plot (Change & Running Average)



Simulation Distribution and Density



Modeling Reserve Risk

Subsequent Actual Development

Calendar Year	Observed Development	Model Probability	Cumulative Probability
2002	693,665	28.2%	28.2%
2003	988,590	13.6%	3.83%
2004	1,141,633	8.5%	0.33%
2005	1,335,960	4.3%	0.01%
2006	518,106	39.5%	0.01%

- Reserving is a *psychosociologicalmanagementactuarial* exercise
- Reserving not driven by unchanging laws of nature
- Social systems characterized by changing rules & extreme fluctuations
- Relevance of old data may be doubtful
- Mack & related triangle based methods assume history fully sufficient
  - Risk in 2001 understated; post-development risk in 2006 may be over-stated
- GIRO and other simple tests such as this indicate to contrary
- Accounting & best estimate requirements vs. insurance cycle

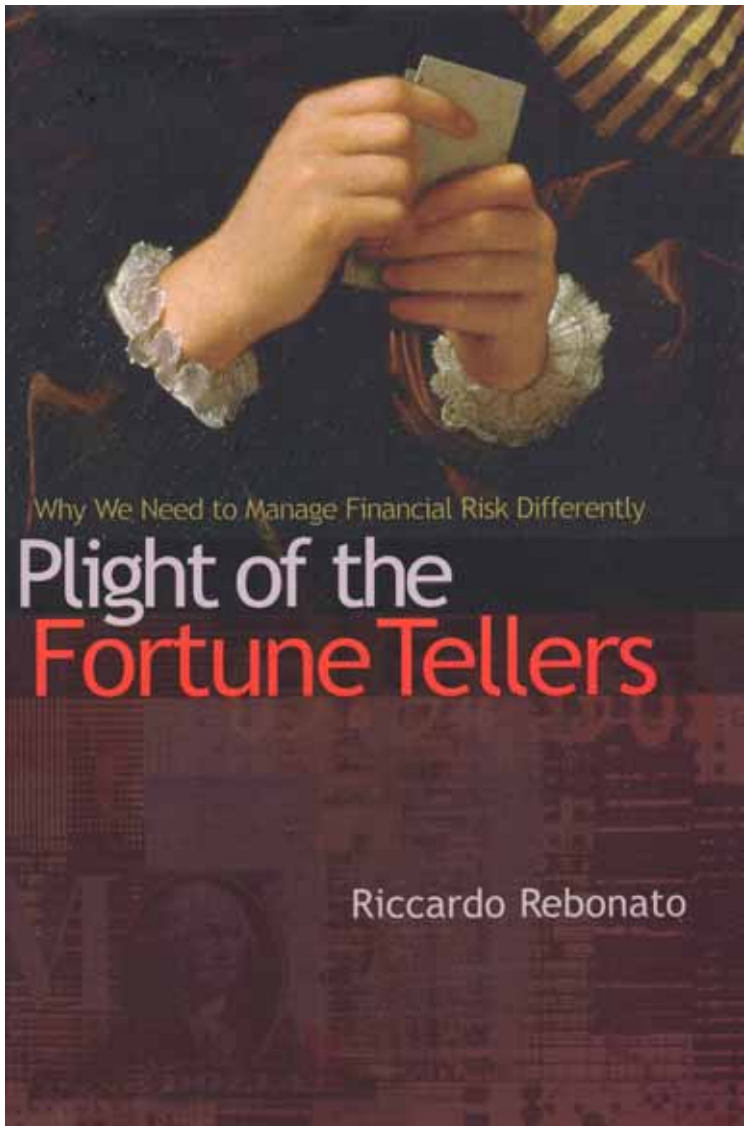
Reserve risk: hard to capture with factor based or stochastic models

Catastrophe Models

After next big hurricane in New England, will model adjustments be made up or down?

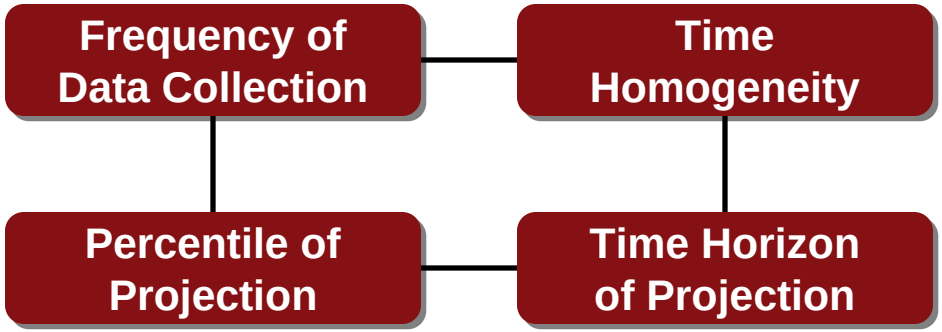
Section 4

Capital Modeling – Realistic Agenda



Princeton University Press, 2007
Riccardo Rebonato global head of market risk and
global head of quantiative research & analysis
Royal Bank of Scotland

"To an extent, if events occur at a given fixed rate that is beyond our control …, and if they are generated by mechanisms that evolve with time, **nature effectively draws a veil over the finer statistical properties of this phenomenon**. Effectively, talking about a very high percentile of a phenomenon that cannot be sampled with arbitrarily high frequency and that is not time-stationary is tantamount to asking a metaphysical question, not an empirical one."



"We *estimate* the probabilities, and from these we *determine* the actions. …the opposite should apply: We *observe* the actions, and from these we *impute* the probabilities."

Stochastic & Structural Models

- "Statistical (frequentist) analysis of publicly available data is of little use in itself to assess the return characteristics of a project"
- Evaluation of return based on subjectivist probabilities
  - Profitable opportunities arise from differentiated firm views about the future
  - Speed of recognition and capitalization on hard market
- Fundamentally more difficult to estimate mean (return) than volatility (risk)
- Stochastic and structural models provide useful framework for incorporating and organizing subjectivist views

Actuarial translation: profitability is projected using trended, developed, on-level, as-if loss ratios

Factor Based Models

- "When it comes to the assessment of the *risk* associated with a given initiative, statistical (frequentist) analysis of historical data often becomes more relevant and useful"

- Evaluation of risk needs to look at an unadjusted historical record
  - Factor based models typically parameterized on such a hind-sight view

- We have re-underwritten the book & cancelled all the money loosing business…

- We won't guess next the systemic loss event…despite our best efforts at risk identification
  - Underwriters avoid making the same mistake twice but won't avoid making new mistakes

- **Actuarial translation: risk is estimated using raw historical ultimate loss ratios**