

GUY CARPENTER

GC Analytics™



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Cat Modeling Uncertainty Mind the Gap

CARe C-6: Catastrophe Pricing

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Mind The Gap

Agenda

- CAS Antitrust Statement & Housekeeping
- Cat Models Matter, but Differ
 - *Is there a “gap”? Does it matter?*
- Modeling Uncertainty, in Theory
 - *Define and quantify*
- Modeling Uncertainty/Bias, in Practice
 - *Data matters a lot*
 - *Models not total representation*
- Multiple Model usage
 - *Incorporate all knowledge*
 - *Avoid analysis paralysis*
- Wrap-up

Essentially, all models are wrong, but some are useful.

George E. P. Box (statistician, past president American Statistical Assn)

Antitrust Notice & Housekeeping

▪ CAS Antitrust Notice

- The Casualty Actuarial Society is committed to adhering strictly to the letter and spirit of the antitrust laws. Seminars conducted under the auspices of the CAS are designed solely to provide a forum for the expression of various points of view on topics described in the programs or agendas for such meetings.
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▪ Housekeeping

- Opinions expressed herein are, at best, presenters' opinions, and may not even be that
- Opinions expressed herein are **not** opinions of the CAS or the presenters' employers

- Use of Jargon:
 - Speak up
 - Ask for definition

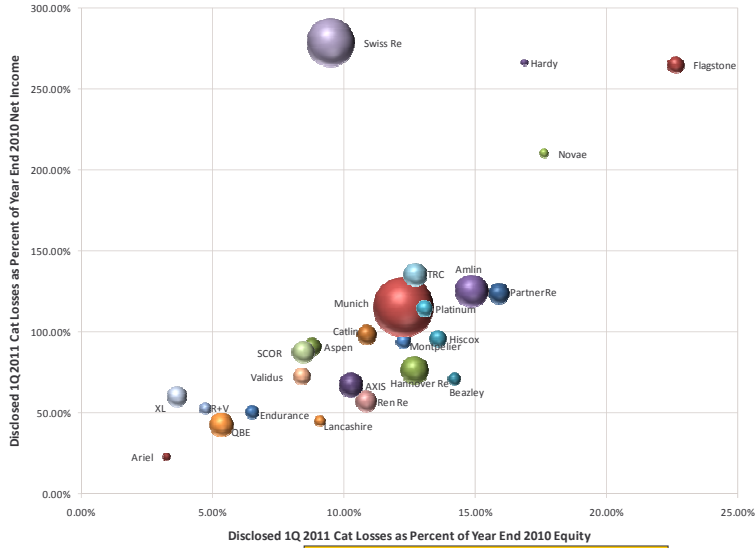
Thesis: Models Matter, but . . . Watch For Delusional Exactitude

“. . .the tendency to imagine that models provide precise numbers that can be used to diversify or price catastrophic risk; these risks, by their very nature, defy exact measurement.”

William I. Riker, (retired) President, Renaissance Holdings
Exposure Magazine, Summer 2004, p. 11.

“Mind the Gap”

Tohoku: Practical Application



Size of bubble represents size of disclosed 1Q loss in U.S. dollars

Reinsurer	1Q Cat Losses Incurred (000,000's)
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Munich	3,702
Swiss Re	2,405
PartnerRe	1,071
Hannover Re	758
AXIS	577
QBE	550
TRC	545
SCOR	486
Ren Re	427
Amlin	425
XL	387
Catlin	375
Validus	294
Aspen	285
Hiscox	266
Flagstone	257
Platinum	248
Montpelier	200
Endurance	185
Beazley	154
R+V	133
Lancashire	117
Novae	80
Ariel	50
Hardy	40

Do you think there was model miss here?

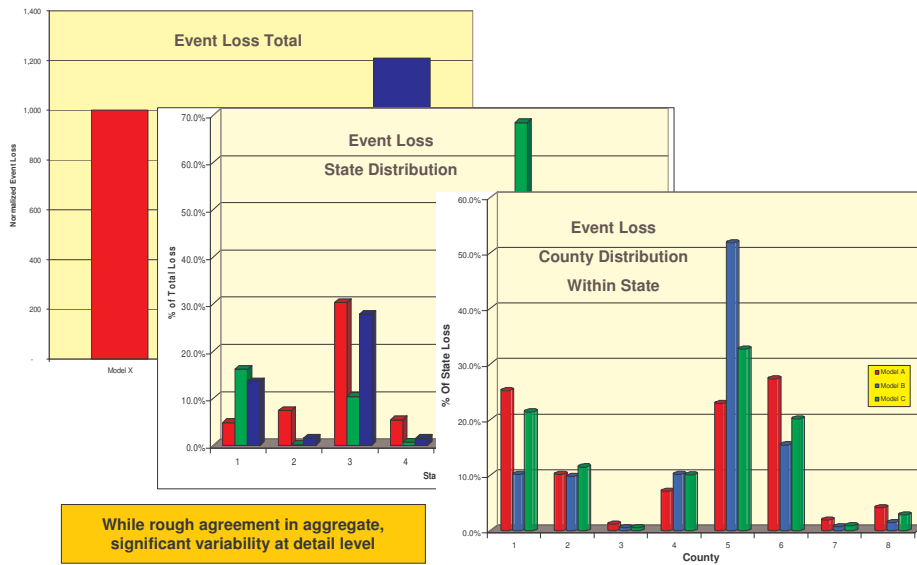
By whom? Does it matter?

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4

Cat Models Do Still Differ

Even if Event Loss Estimates Similar



While rough agreement in aggregate, significant variability at detail level

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5

Cat Models Do Still Differ

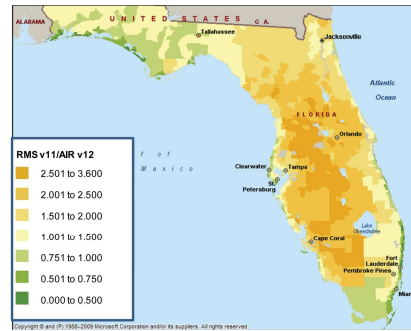
Even in Area with the Most Claims Data

OCCURRENCE LOSS RESULTS FOR 2007 FHCF COMBINED PERSONAL AND COMMERCIAL RESIDENTIAL EXPOSURE (FORM A-9,PART D)

Return Period (Years)	AIR CLASIC2 v12		RMS RiskLink v11	
	Estimated Loss (Millions)	Uncertainty Interval (Millions)	Estimated Loss (Millions)	Uncertainty Interval (Millions)
Top Event	371,775		586,165	397,106 to 795,996
1,000	162,813	148,138 to 173,329	151,142	81,006 to 237,592
500	124,210	110,942 to 136,709	115,015	65,705 to 170,405
250	97,182	93,217 to 105,169	86,977	47,963 to 135,074
100	61,087	58,350 to 64,377	58,038	31,348 to 91,291
50	40,244	38,704 to 41,929	40,731	19,583 to 68,119
20	19,422	18,720 to 20,148	22,560	9,473 to 40,128
10	9,794	9,470 to 10,040	11,765	6,873 to 17,734
5	3,528	3,399 to 3,641	3,903	367 to 10,501

Source: Florida Commission on Hurricane Loss Projection Methodology

RATIO OF RMS V11 TO AIR V12 LOSS COST BY ZIP

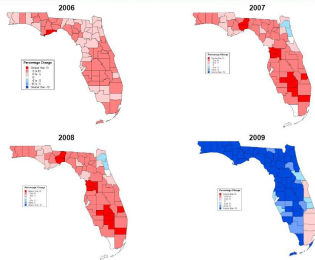


Source: Guy Carpenter & Company, LLC

Implications for territorial pricing
Implications for portfolio management

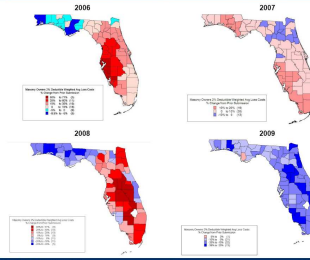
Individual Cat Models Change Too

AIR Annual Changes Loss Costs By County



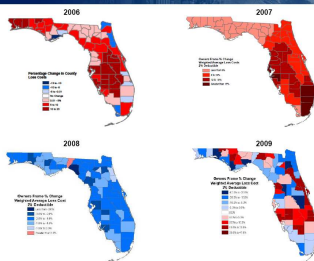
KAREN CLARK & COMPANY

EQECAT Annual Changes in Loss Costs By County



KAREN CLARK & COMPANY

RMS Annual Changes in Loss Costs By County



KAREN CLARK & COMPANY

Source: FCHLPM, via Karen Clark & Company

Why Don't The Models Agree?



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8

Modeling Uncertainty

Sources

- Uncertainty (not randomness)
 - Sampling Error
 - 100 years for hurricane
 - Specification Error
 - FCHLPM sample dataset (1996) 1 in 100 OEP of 31m, 38m, 40m & 57m w/ 4 models
 - Non-sampling Error
 - El Nino Southern Oscillation
 - Knowledge Uncertainty
 - Time dependence, cascading, aseismic shift, poisson/negative binomial
 - Approximation Error
 - Original Res Re cat bond: 90% confidence interval, process risk only, of +/- 20%, per modeling firm

Source: Major, John A., "Uncertainty in Catastrophe Models,"
Financing Risk and Reinsurance, International Risk Management
Institute, Feb/Mar 1999.

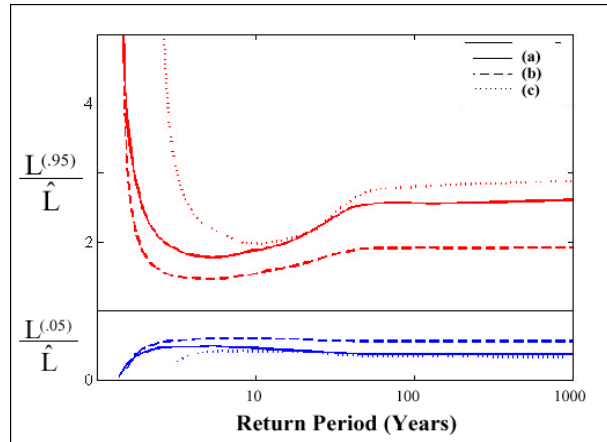
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9

Modeling Uncertainty

David Miller's Experiment

- Parameterized bootstrap re-sampling

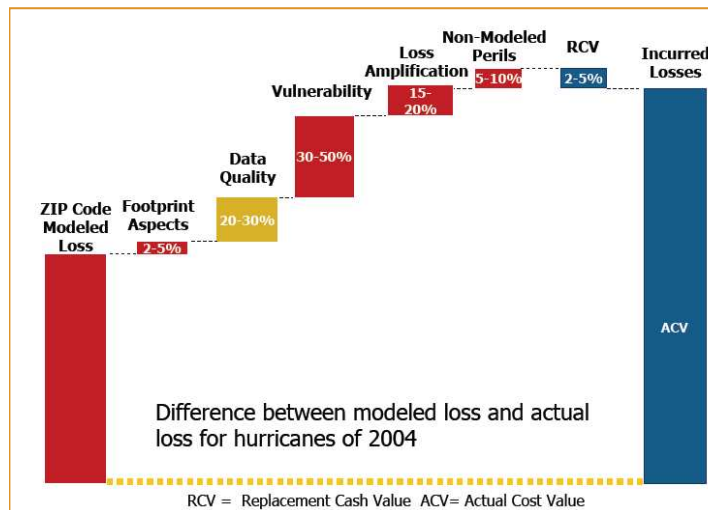


Source: Miller, David, "Uncertainty in Hurricane Risk Modeling and Implications for Securitization," CAS Forum, Spring 1999.

90% confidence bound: 50-250% of point estimate

Model Miss

Models Change/Incorporate New Knowledge



Source: RMS

Model Miss

Models Inputs Matter: Underinsurance

Table 1: Comparison of Replacement Values for Representative Properties

	Occupancy	Con-struction	Approx. Gross Area (sq. ft.)	Replacement Value		
				Company Provided Value	AIR Estimate	Ratio
	Hotel	Wood Frame	30,000	\$1,692,702 <i>i.e., \$56/sq ft</i>	\$3,509,831	48%
	Retail	Masonry	100,000	\$1,243,816 <i>i.e., \$12/sq ft</i>	\$8,484,046	15%

Overall, nine out of ten commercial properties analyzed had replacement values less than the amount estimated using a standard engineering-based cost estimation process.

AIR, Nov. 2005

- 58 percent of US homes underinsured last year by an average 21%
 - Marshall & Swift/Boeckh, quoted in USA Today, Nov. 1, 2007
- Reconstruction often more expensive than replacement
 - www.nationwide.com/underinsurance.jsp
- Model calibration will pick some underinsurance

Data Matters

Policy Capture: The Basic Building Block

- How many policy systems?
- Stat record vs. policy systems
- Manual policies
- Written by foreign office
- Geography
 - All States? Coastal states?
 - States captured for New Madrid?
 - Northwest?
- Lines of business:
 - APD, IM, Floaters, DW Fire
 - Watercraft, Yachts, Offshore
- New programs, acquisitions
- **Business Unit Compliance**

Did you capture the policy?

Data Matters

From Policy System to Model Input

- Model exception report: Read It
 - geocoded/not geocoded
 - imported/not imported
- Bulk coding on multi-location policies
- Building location/billing location
- Endorsements, sublimits, exclusions
- Construction
 - ISO fire mappings
 - Mixed construction
 - Year built
- HPR, Excess, Blankets
- Secondary Modifiers
 - Lake Wobegon?

Did you model the policy appropriately?

Visuals: Data Matters

Boat Storage Hangar – Contents Matter



Photo: Wyndham Partners

Visuals: Data Matters
Construction Detail - Year Built



**Pre-1994 construction vs
2003 Construction**
Homes <200 yards apart

Photos: Wyndham Partners
Guy Carpenter

Visuals: Data Matters
Construction Detail – MHO Year Built



Pre-1994 and post-1994 FL MHO construction

Photos: Wyndham Partners
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Visuals: Data Matters

Construction Detail - Roof Attachment



Photos: Wyndham Partners
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18

Visuals: Data Matters

Construction Detail - Mixed Construction



Photos: Wyndham Partners
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19

Models Not Total Representation

Model Miss (besides data issues)

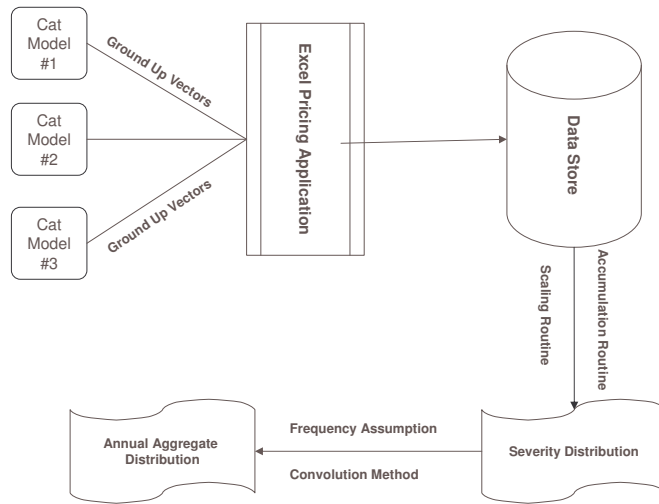
- How was model run?
- Loss adjustment expense
 - vary by size of loss
 - HU vs EQ vs other
 - employee vs TPA
- Pool assessments
- Insolvency assessments
- Flood (partial, maybe)
- Inland wind (partial)
- Contingent Business Interruption
 - \$1b CBI claim (policy sub-limit) by one insured in Tohoku
- Local ordinances
 - Red flagging, etc
- Non-property lines: WC, Liability, A&H, (Group) Life, LTD, etc.

Multiple Model Usage

Incorporating Knowledge

- Standard control theory tells a decision maker how to make optimal decisions when his model is correct. The post-modern control theorist regards his model as an **approximation** to an **unknown and unspecified model** that he thinks actually generates the data. He seeks **robust** decision rules and estimators that work over a **set** of models **near** his approximating model.”
 - *L. P. Hansen and T. J. Sargent, Robustness (2007)*
- Adjust model output
 - scalar/vector/non-linear function
 - by region/peril/business unit/etc
 - by layer
- Multiple models (cost vs return issue)
 - Some form of model averaging
 - of results or of inputs?
 - Or primary model with secondaries as modifiers
 - Different primary by region
- Implications for portfolio management

Multiple Model Usage Stylized Representation



Source: Peter Martin, CArE LAS Presentation

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22

Conclusions

- **Cat Model Distributions Vary**
 - More than one point estimate useful
 - Point estimates may not be *significantly* different
 - Uncertainty not insignificant but not insurmountable
 - *What about uncertainty before cat models?*
- **Data Inputs Matter**
 - Not mechanical process
 - Creating model inputs requires many decisions
 - User knowledge and expertise critical
- **Judgment Unavoidable**
 - Actuaries well-versed here

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23