Liberty Mutual Group

PEBELS:
Policy Exposure Based Excess Loss Smoothing

Marquis J. Moehring

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Outline

1. Background
2. Goal
3. PEBELS Defined
4. PEBELS Derived (PPR Generalized)
5. Applications
6. Summary

My Challenge

Strong Regional Focus

- State/Program Large Loss Provisions
- Low Credibility
- High Heterogeneity

This Should be Easier

No applicable method in literature

- ILFs for Liability
- ELFs for Workers Compensation
- **Nothing for Commercial Property or Homewners!**

Goal of PEBELS

PEBELS = Property Large Loss Exposure Segmentation

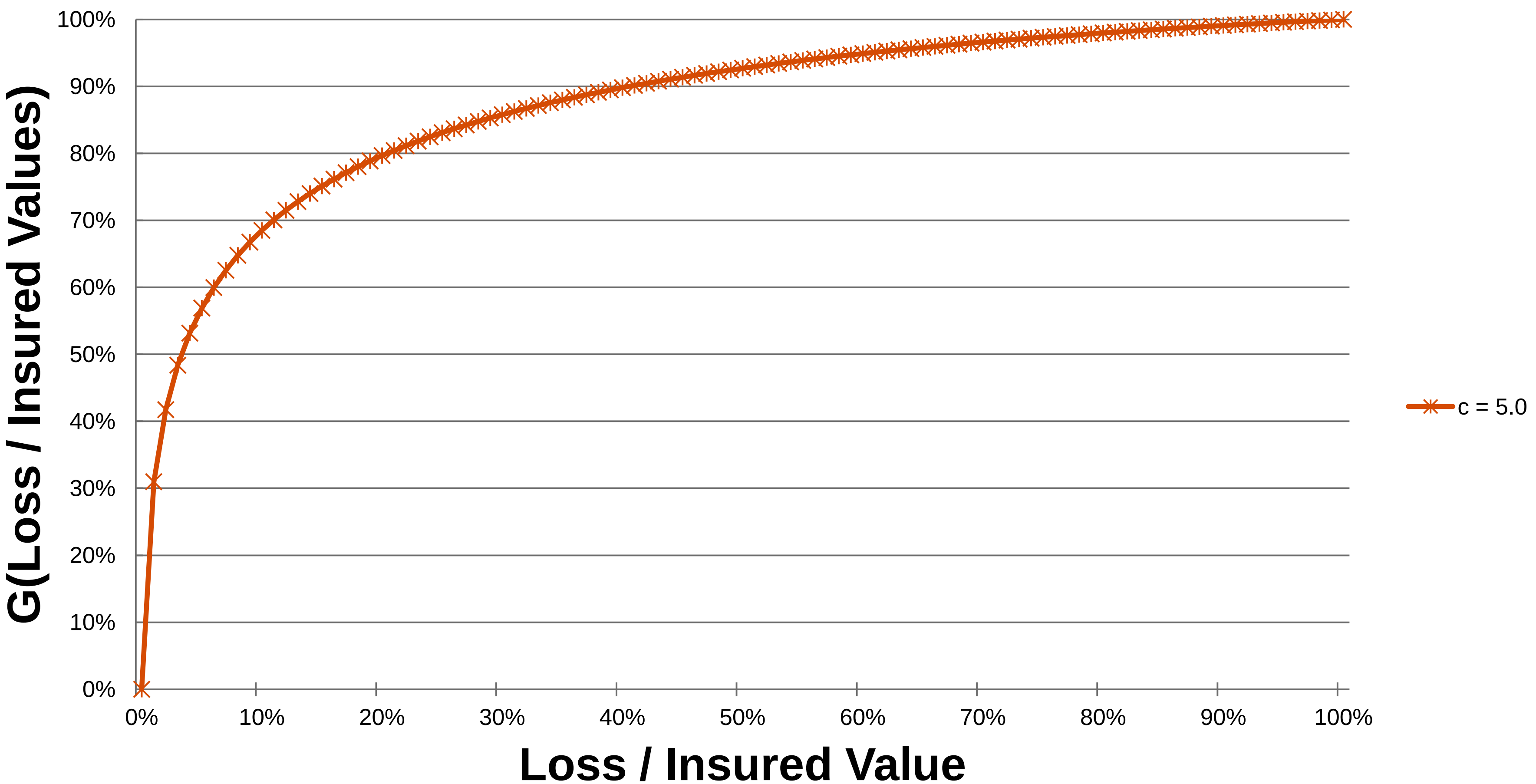
- Meet my challenge
- New applications!
- Deceptively difficult
  1) No clear limit
  2) Multiple non-linearities
  3) Additional nuances
  4) Practical considerations

PEBELS Defined

Defined as $\boldsymbol{PEBEL_i = P_i * ELR_i * EF_i}$

- $P_i * ELR_i = E(L_i) = Total\ Expected\ Loss$
- $EF_i = G(x_u) - G(x_l) = Percentage\ of\ E(L_i)\ in\ layer$

Exposure Curve



PEBELS Derived

PEBELS Derived = PPR Generalized

- Classic Reinsurance Per Risk Exposure Rating
- Generalized to contemplate,
  1) Policy level heterogeneity
  2) Expected loss heterogeneity via ELR_i
  3) Loss process heterogeneity via EF_i
  4) Historical vs. prospective exposure profiles
  5) Credibility

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Reinsurance Per Risk Exposure Rating

Insured Value Range ($000s)	Midpoint ($000s)	Retention as a % of Insured value	Retention + Limit as a % of Insured value	Exposure Factor	Subject Premium	Expected Loss Ratio	Expected Primary Losses	Expected Reinsurer Losses
20-100	60	167%	833%	0%	682,000	65%	443,300	0
100-250	175	57%	286%	26%	161,000	65%	104,650	27,209
250-1,000	625	16%	80%	41%	285,000	65%	185,250	75,953
1,000-2,000	1,500	7%	33%	33%	1,156,000	65%	751,400	247,962
Grand Total					2,284,000	65%	1,484,600	351,124

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Per Policy Generalization

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Heterogeneity Generalization

$$\underline{PEBEL_i = P_i * \boldsymbol{ELR_i} * EF_i}$$

- Expected catastrophe loss
- Risk loads
- Rate adequacy

State:	House
X	65.0%
Y	65.0%
Z	40.0%

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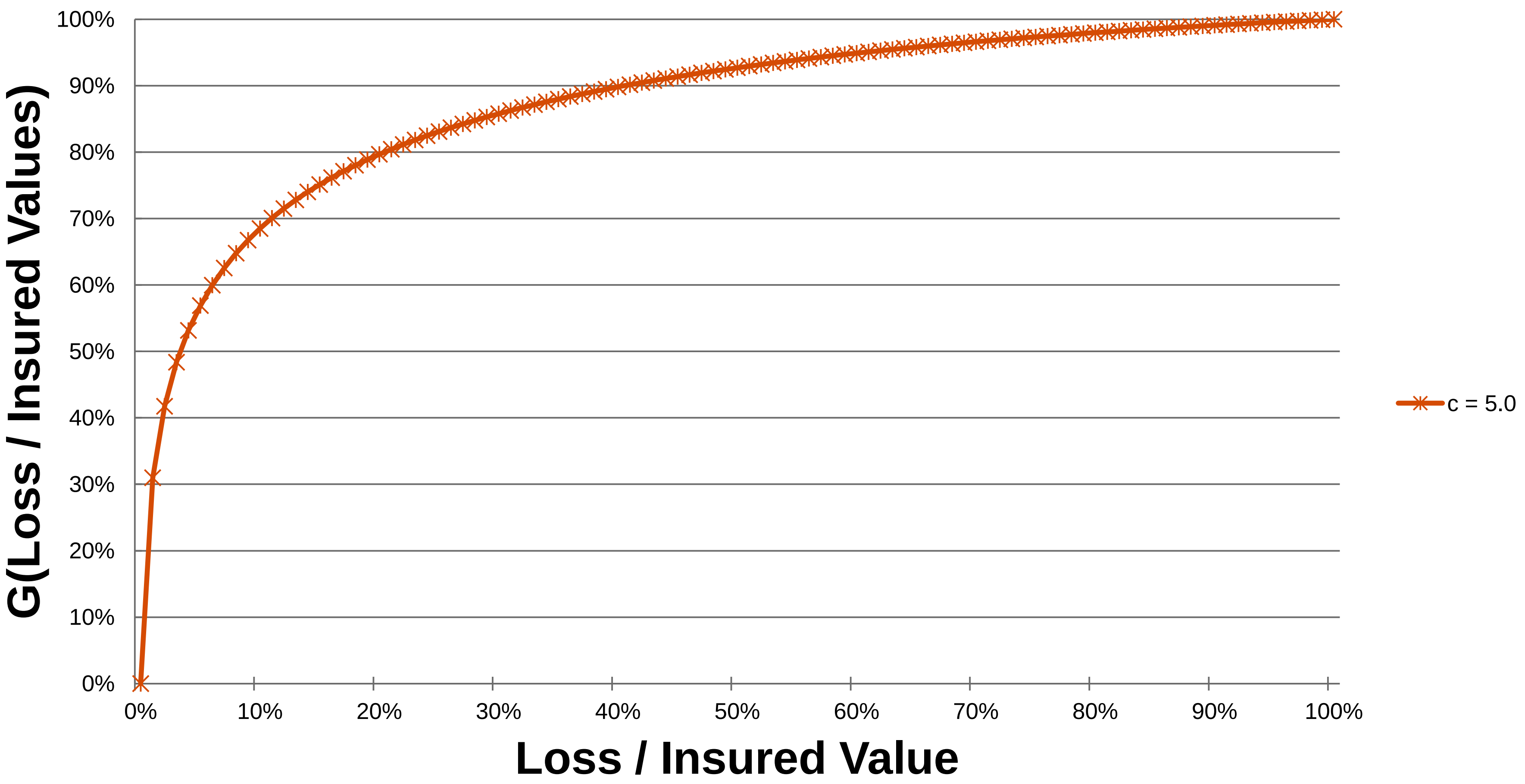
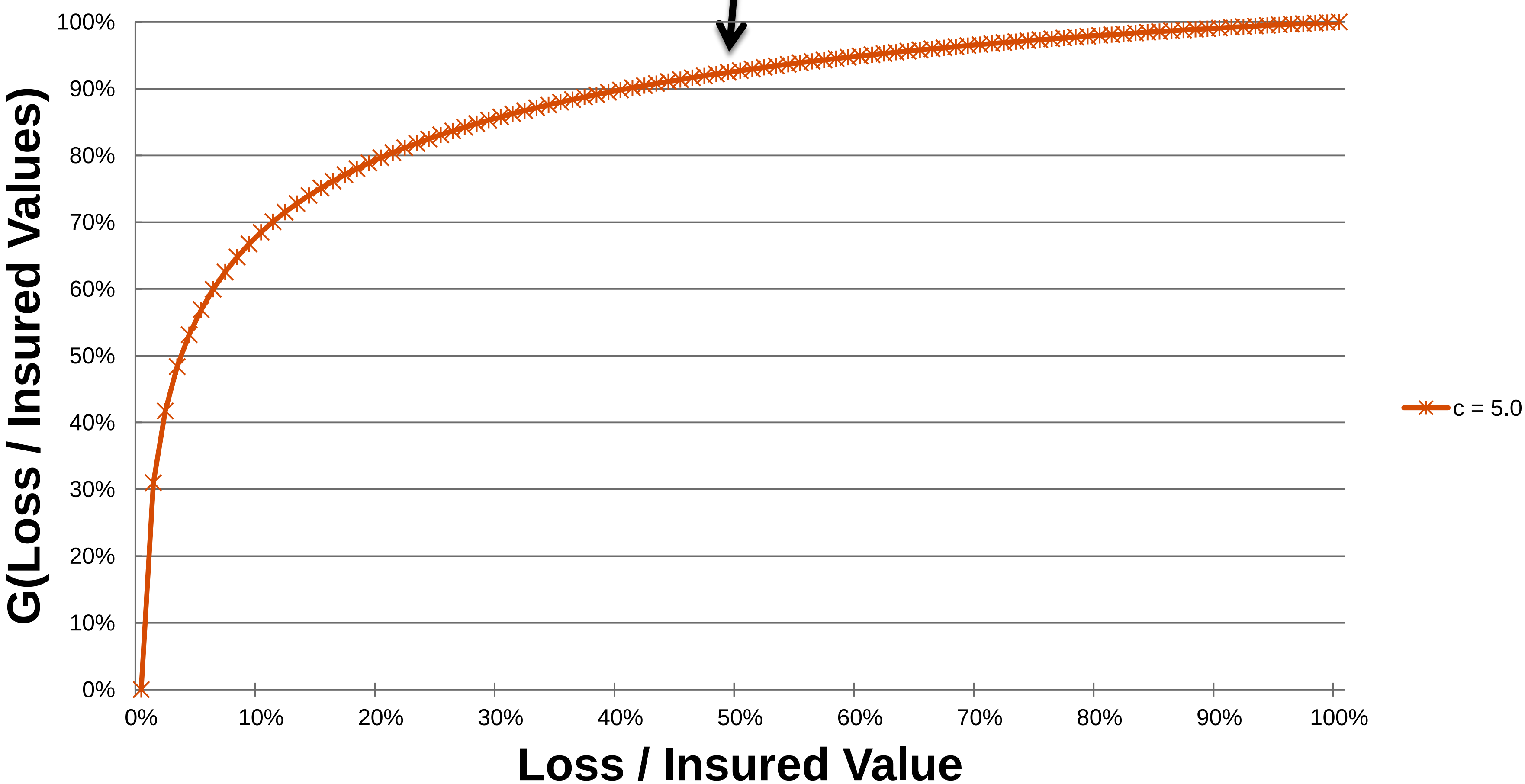


Exposure Curve

Dispersed: e.g. Estate / University Campus



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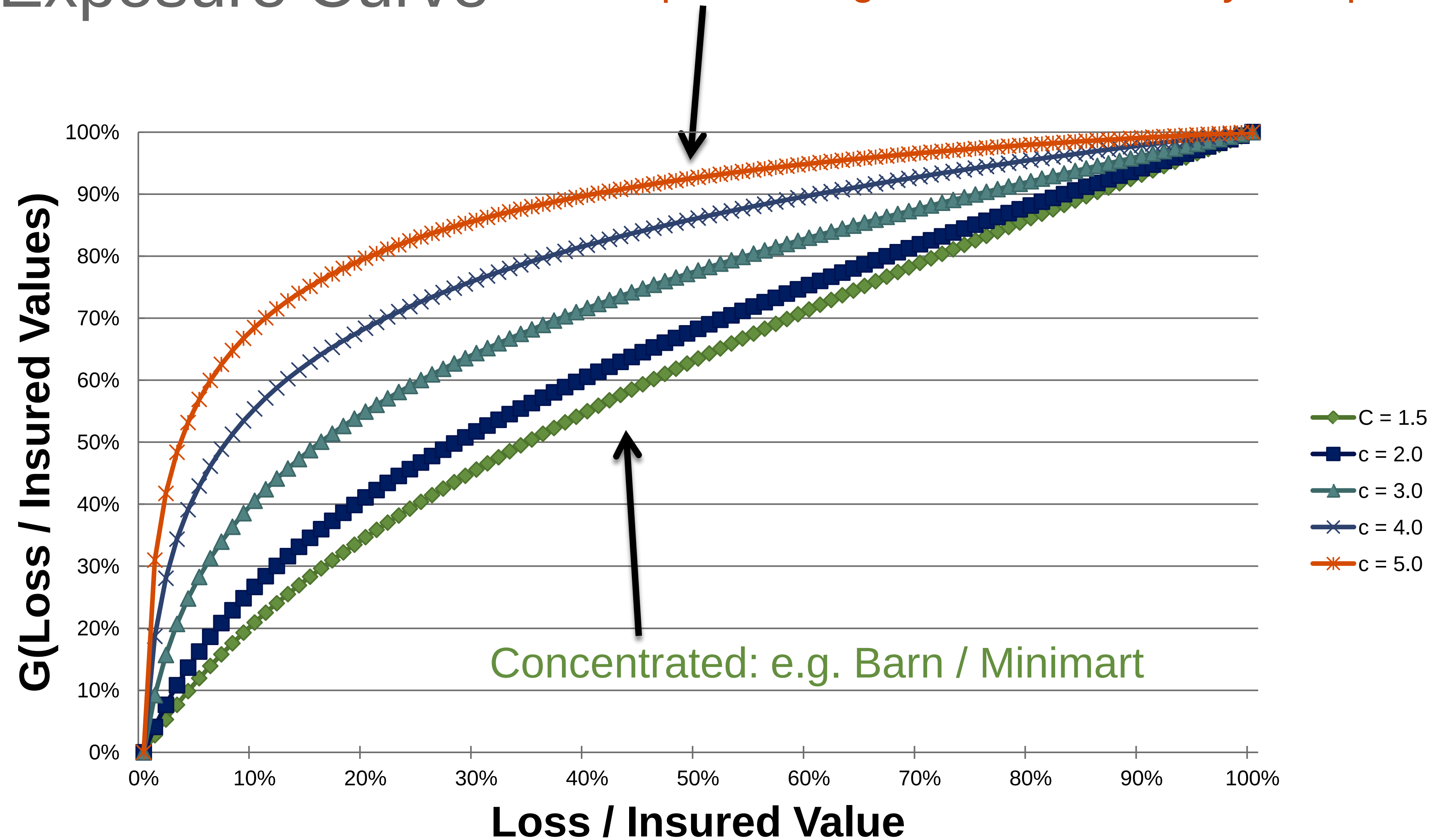

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Applications

<u>Indications</u>

- Motivated PEBELS
- Allocate large losses to state and program
  - Low credibility
  - High heterogeneity in underlying exposures

Applications

Adjusted Modeled Catastrophe AALs

- Traditionally assume AAL linear with IV
- This contradicts
  - Theory presented
  - Ludwig’s study of Hurricane Hugo
- Implies bias between Personal & Commercial
- Can adjust AALs with PEBELS

Applications

Predictive Models

Hypothesize that PEBELS

- More predictive of large loss than IV
- Most predictive for highly skewed perils
- Most predictive in severity/excess models

Applications

Revised Property Per Risk Reinsurance Exposure Rating

Current formulation:

$$NCLL^{Expected\ Prospective}_{Non-Credible\ Higher\ Layer} = NCLL^{Historical}_{Credible\ Lower\ Layer} * \frac{PEBEL^{Prospective}_{Non-Credible\ Higher\ Layer}}{PEBEL^{Prospective}_{Credible\ Lower\ Layer}}$$

Applications

Revised Property Per Risk Reinsurance Exposure Rating

Proposed formulation:

$$NCLL_{Non-Credible\ Higher\ Layer}^{Expected\ Prospective} = (NCLL_{Credible\ Lower\ Layer}^{Historical}) *$$

$$\left(\frac{PEBEL_{Non-Credible\ Higher\ Layer}^{Historical}}{PEBEL_{Credible\ Lower\ Layer}^{Historical}}\right) * \left(\frac{PEBEL_{Non-Credible\ Higher\ Layer}^{Prospective}}{PEBEL_{Non-Credible\ Higher\ Layer}^{Historical.Annualized}}\right)$$

Summary

PEBELS = Property Large Loss Exposure Segmentation

- Only game in town
- Quantifies messy non-linearities
- Multiple applications
  - Indications
  - Catastrophe Modeling
  - Risk Segmentation

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Historical vs. Prospective

Selecting exposure profile for the application?

Prospective (current inforce)

- Catastrophe modeling
- Reinsurance quotes

Historical (“earned” over experience period)

- Loss ratio ratemaking
- Revised per risk reinsurance exposure rating

Historical vs. Prospective

Loss ratio ratemaking examples

1) State in run-off scenario
2) State newly entered scenario

Both scenarios lead to skewed state indications

Even small shifts will distort indications

Credibility

<u>Indications example</u>

Layer experience to maximize credibility

<u>Complements</u>

$$1)\quad NCLL^{Historical}_{\$0.1M\ to\ \$0.5M} * \frac{PEBEL^{Historical}_{\$0.5M\ to\ infinity}}{PEBEL^{Historical}_{\$0.1M\ to\ \$0.5M}}$$

$$2)\quad (Direct\ EP) * (Reins.Rate) * (Reinsurer's\ PLR)$$

Appendix

Misc. Topics

- Exposure curve considerations
- Data limitations and NLE
- Methods in common usage