ACCIDENT YEAR / DEVELOPMENT YEAR INTERACTIONS

November 16-18, 2015

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Munich RE

Motivation

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- Predominant use of ad hoc models in the actuarial reserving practice
- Theoretical actuarial research is actively suggesting new solutions based on unified theory
- Research fails to quickly gain the practitioner's acceptance

Ad Hoc Model → **Question**

Unified Theory Model →

Motivation

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Goal: Bring the work of the practicing actuary and the theoretical actuary closer together by:

- Highlighting the benefits of using advanced models
- Recognizing that the theoretical research needs to be more flexible and accessible for the practicing actuary

*"A sentiment was growing that much of the current actuarial literature had become **overly technical**, **impractical for use** in everyday actuarial work, and far too difficult to describe to a nonactuarial audience.''*

*"It is important that our work be **clear enough for other actuaries to follow** if we have any hope that a nonactuarial audience can follow it."*

Lynne M. Bloom – "Nontechnical Reserve Call Papers Reach a Wider Audience", Actuarial review, Jan/Feb 2014

The challenge for the reserving actuary

THE THEORY:

Loss development patterns are stable over time

THE REALITY:

Loss development patterns are changing over time

THE CHALLENGE:

or

Identify the nature of the change

(i.e. Find the confounding variables that cause the AY/DY interaction)

AY/DY interactions

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FACTORS

- Change in business mix
- Change in procedures
- Missing/incomplete data
- Commutations
- Tort reforms
- Trends/Inflation

PRACTICAL SOLUTIONS

Data substitution or subdivision

Case reserve adjustments

Berquist and Sherman, Duvall

Settlement rate adjustments

Berquist and Sherman, Fleming and Mayer

Incremental method

Sherman-Diss

Calendar year trend methods

Taylor, Butsic, Barnet and Zehnwirth, Gluck and Venter

OLD

“Only the latest diagonal” model

AY/DY interactions

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FACTORS	PRACTICAL SOLUTIONS
• Change in business mix	Data substitution or subdivision
• Change in procedures	Case reserve adjustments *Berquist and Sherman, Duvall*
• Missing/incomplete data	Settlement rate adjustments *Berquist and Sherman, Fleming and Mayer*
• Commutations	Incremental method - MIT *Sherman-Diss*
• Tort reforms	Calendar year trend methods *Taylor, Butsic, Barnet and Zehnwirth, Gluck and Venter*
• Trends/Inflation	OLD *"Only the latest diagonal" model*

Incremental method – Example

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The mechanics of the Incremental method:

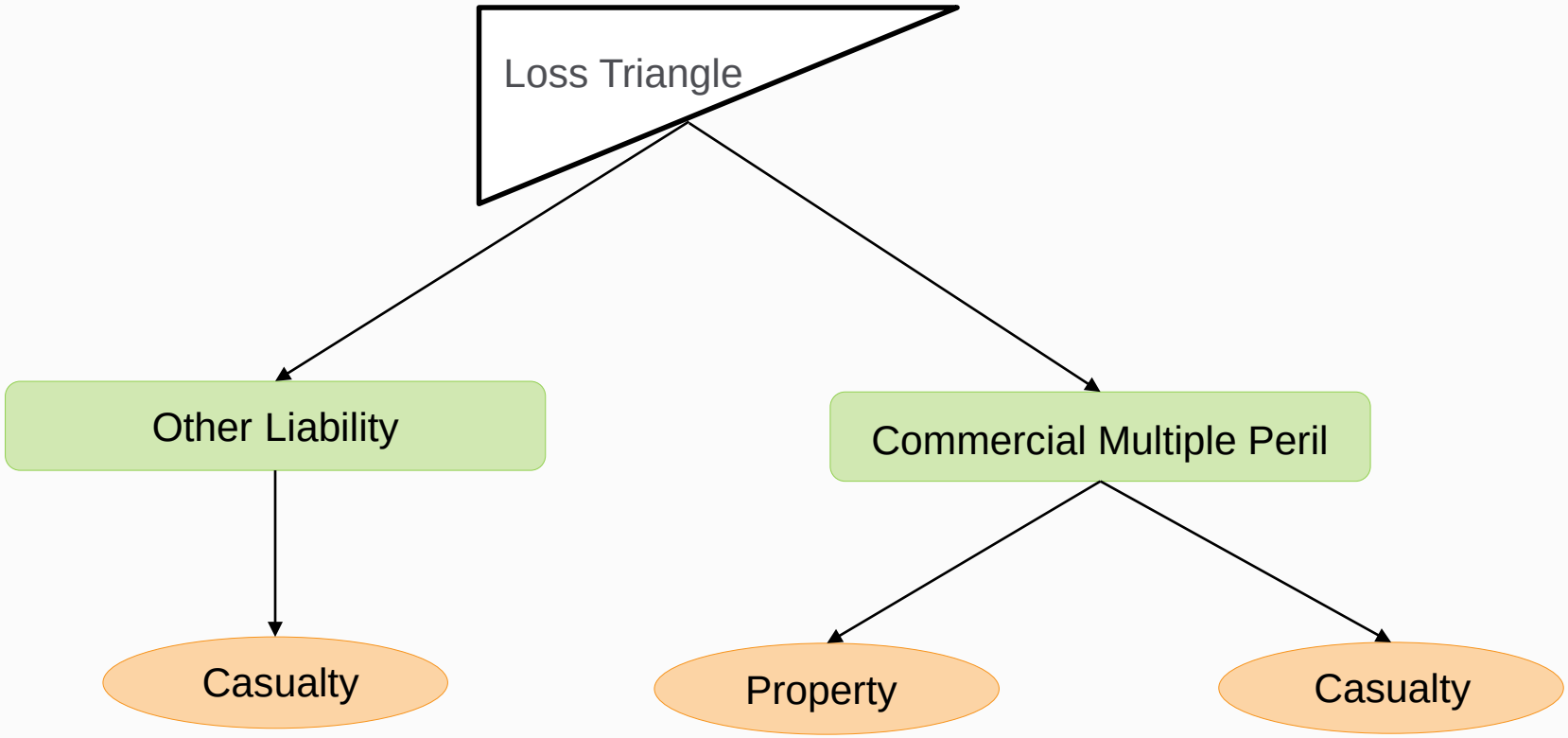
1. Calculate incremental paid loss amounts

2. Calculate an **anchored decay factor** representing the **incremental payments** made in year N relative to payments made in an anchor year Y

Incremental decay factors : $\frac{Loss_6}{Loss_5}; \frac{Loss_7}{Loss_5}; \ldots \frac{Loss_{37}}{Loss_5}$

Cumulative decay factor : $\frac{Loss_6}{Loss_5} + \frac{Loss_7}{Loss_5} + \ldots + \frac{Loss_{37}}{Loss_5}$

Incremental model – Example



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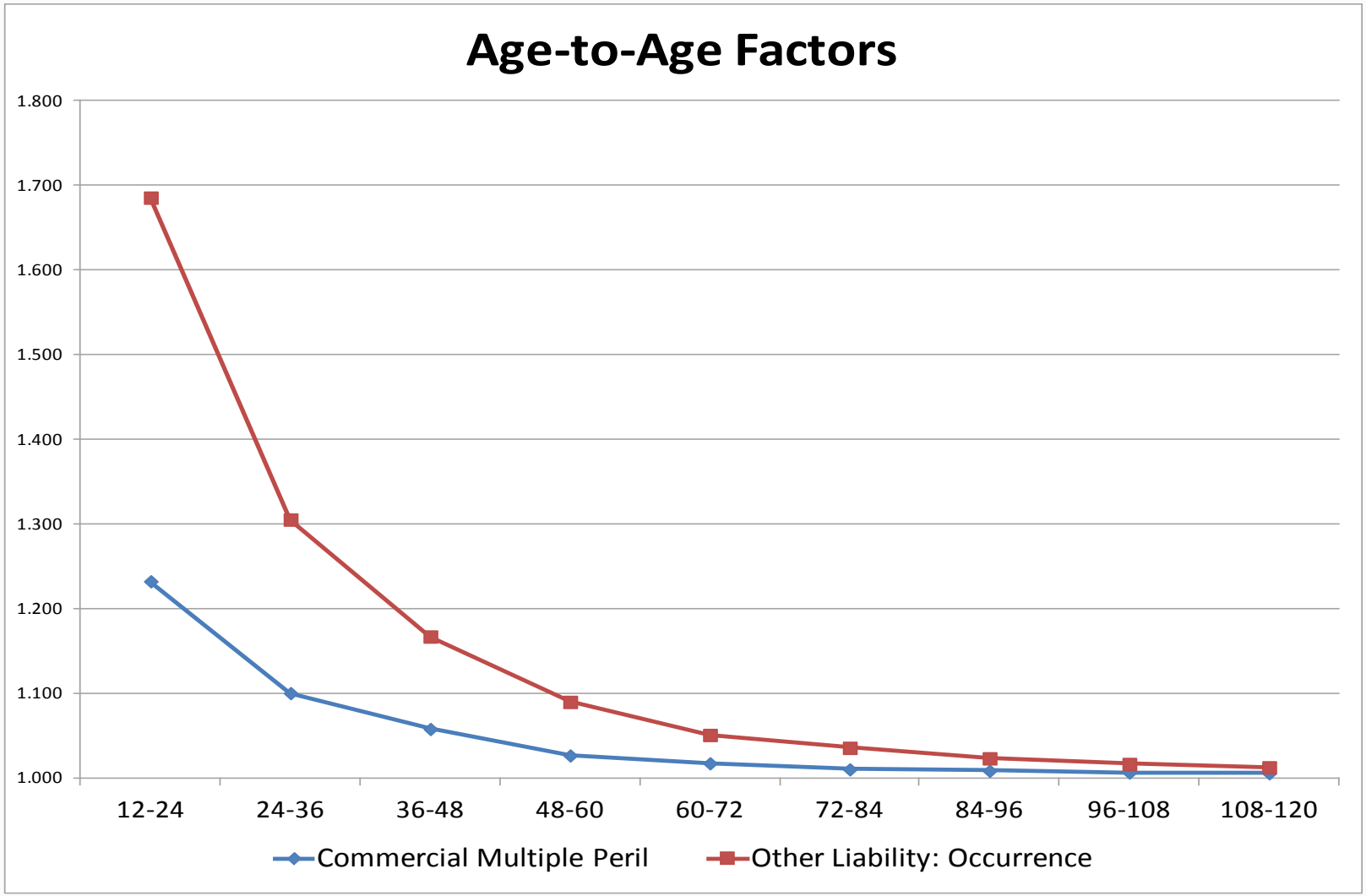

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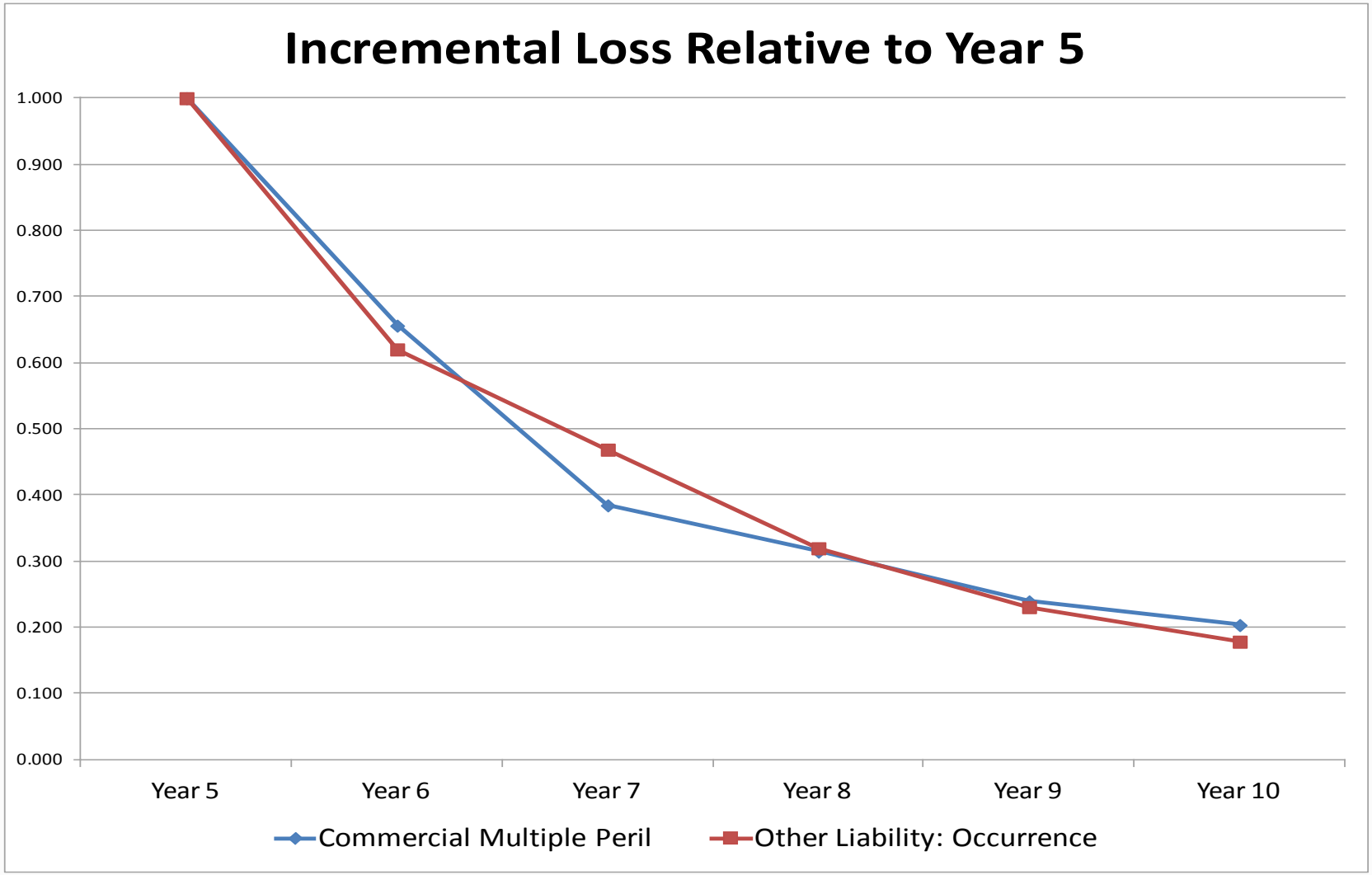

Identifying the causes of AY/DY interactions

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- Ratio diagnostics

  Ratio of paid to reported loss

  Ratio of paid loss to on-level earned premium

  Ratio of reported loss to on-level earned premium

  Ratio of reported loss to reported claim counts

  ….

- Gathering meaningful information to build the true story

  The danger of “quick and slick” answers that are designed to bias the analysis

  Richard E. Sherman – “Updating the Berquist Sherman Paper - Thirty Years Later”

- Heat Maps – color representation of the data

Heat Maps

Paid Loss Triangle

AY	12	24	36	48	60
1	159	413	677	775	791
2	154	401	656	778	793
3	145	389	615	769	785
4	151	394	644	755	788
5	146	399	620	762	770
6	161	411	626	739	
7	158	412	556		
8	150	367			
9	113				

Reported Loss Triangle

AY	12	24	36	48	60
1	477	620	744	791	791
2	462	601	721	793	793
3	434	584	677	785	785
4	454	591	709	770	830
5	437	598	682	811	811
6	482	617	783	786	
7	473	687	695		
8	556	612			
9	420				

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Identifying the causes of AY/DY interactions

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Slow Development - Growing Volume

AY	12	24	36	48	60
1	100	200	250	275	290
2	300	600	750	825	
3	500	1000	1250		
4	700	1400			
5	900				

AY	12-24	24-36	36-48	48-60
1	2.000	1.250	1.100	1.055
2	2.000	1.250	1.100	
3	2.000	1.250		
4	2.000			

Quick Development - Shrinking Volume

AY	12	24	36	48	60
1	900	1350	1395	1395	1395
2	700	1050	1085	1085	
3	500	750	775		
4	300	450			
5	100				

AY	12-24	24-36	36-48	48-60
1	1.500	1.033	1.000	1.000
2	1.500	1.033	1.000	
3	1.500	1.033		
4	1.500			

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3	1.500	1.033		
4	1.500			

All Policies Combined

AY	12	24	36	48	60
1	1000	1550	1645	1670	1685
2	1000	1650	1835	1910	
3	1000	1750	2025		
4	1000	1850			
5	1000				

AY	12-24	24-36	36-48	48-60
1	1.550	1.061	1.015	1.009
2	1.650	1.112	1.041	
3	1.750	1.157		
4	1.850			

Identifying the causes of AY/DY interactions

The Simpson's Paradox: sub-portfolios have patterns that are unchanging and perfectly stable over time, but the changing mix gives an appearance of a changing pattern for the combined business.

Slow Development - Growing Volume

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The challenge of the ad hoc models

The commonly used methods assume:

- The changing development pattern is due to a single cause
- An adjustment to the triangle can be made which will make the patterns consistent over time, “all else being equal”

Ad Hoc Model → **Factor**

Unified Theory Model →

Procedures
Inflation **Legal changes**
Business mix
Loss Trends
Missing data

Statistical Models

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- **GLM** – A flexible framework for modeling the relationship between the explanatory variables and the response variable, and the variance structure of that response variable
  - ✓ Good for modeling AY/DY interaction
- **Hierarchical or "Mixed" Models** – A GLM variation that allows looking at multiple triangles simultaneously
  - ✓ Good for addressing changes in mix of business
- **Models Using Detailed Data**
  - ✓ Good for addressing mix of coverages, types of losses, policy limits
- **Bayesian Models –** Allows the user to apply prior knowledge of development factors and variables influencing the development patterns
  - ✓ Good for handling very complex non-linear AY/DY interactions

The way forward ...

for the reserving practice

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- Invest in the implementation of statistical models for reserving

- Use more data, not less!

“A danger of using summarized loss triangles is that they can mask heterogeneous loss development patterns.”

Guszcza and Lommele - “Loss Reserving Using Claim-Level Data” CAS Forum, Fall 2006

The way forward ...

for the theoretical research

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- A unified theory model should be able to handle AY/DY interactions regardless of the factor that caused them
- How to make a model easily absorbed by practicing actuaries?
  - ✓ Model flexibility to allow clear intervention points for the reserving actuary
  - ✓ Create a library of the form of interactions appropriate for different factors
  - ✓ Model implementation should be more accessible and practical

Practical?

Accessible?

Easy implementation?

Unified Theory Model

Flexible?

Transparent?

"Clear enough for other actuaries to follow"?

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