With the Benefit of Hindsight
An Analysis of Loss Reserving Methods

Prepared for: International Congress of Actuaries
Washington, D.C.

Prepared by: Susan J. Forray, FCAS, MAAA
Principal and Consulting Actuary
susan.forray@milliman.com
(262) 796-3328

April 2014

Milliman

So Many Methods, So Little Time

Paid Chain Ladder,
Bornhuetter-Ferguson,
Backwards Recursive,
Munich Chain Ladder…

Claims Closure,
Hindsight Outstanding,
Frequency Severity,
Benktander…

Milliman

Overview

- § Scope of Review
- § The Methods
- § The Metric
- § Results
  - – Development Age
  - – Line of Business
  - – Company Size
- § How Useful Are These Results?
  - – Correlation
  - – Significance
- § Conclusions

Milliman

 Copyright © 2007

SCOPE OF REVIEW

4 Milliman

Scope of Review

- § 3,110 Companies
- § 16 Lines of Business
- § 14 Evaluations (Excluding 2010)
- § 30 Methods

- § Hindsight Indications
  - – 20.9 Million In Theory
  - – 4.9 Million In Fact

5 Milliman

THE METHODS

6 Milliman

 Copyright © 2007

Methods – Chain Ladder

- Standard Chain Ladder
  - Paid
  - Incurred
  - Case Reserve
- Berquist-Sherman (Case Adjustment)
- Munich Chain Ladder
  - Paid
  - Incurred

7 Milliman

Methods – Incremental

- Incremental Additive
  - Paid
  - Incurred
  - (Normalized using net earned premium)
- Incremental Multiplicative
  - Paid (paid on prior paid)
  - Incurred (incurred on prior incurred)
- Backward Recursive
  - Paid on prior case / case on prior case

8 Milliman

Methods – Least Squares

- Brosius
  - Paid
  - Incurred
- Weighted Brosius
  - Paid
  - Incurred

9 Milliman

 Copyright © 2007

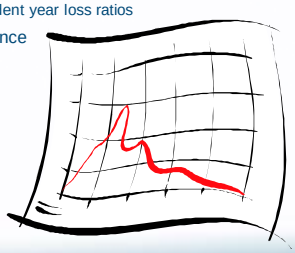
Methods – Count-Based

- Frequency / Severity
- Hindsight Outstanding – Unpaid
  - Average unpaid loss per yet to close claim
- Hindsight Outstanding – IBNR
  - Average IBNR loss per yet to close claim
- Claims Closure
  - Projection of claims to close by development period
  - Paid loss per yet-to-close claim

10 Milliman

Methods – Loss Ratio

- Industry-Based
  - AM Best projections of accident year loss ratios
- Based on Company Experience
  - All prior years
  - Three prior years



11 Milliman

Methods – Composite

- Bornhuetter-Ferguson
  - Industry loss ratio
    - Paid
    - Incurred
  - Method-based prior years' loss ratio
    - Paid
    - Incurred
- Benktander
  - Paid
  - Incurred
- Cape Cod
  - Paid
  - Incurred

12 Milliman

 Copyright © 2007

THE METRIC

13

Milliman

The Metric: "Method Skill"

§ Error = Indicated Unpaid Ratio to Premium
– Hindsight (HS) Unpaid Ratio to Premium

§ Anomaly = Hindsight Unpaid Ratio to Premium
– Wtd Avg HS Unpaid Ratio to Premium

§ Weighted average is across accident/report years

§ Observations:
- Anomaly is a property of the data
- Error is a property of the method

14

Milliman

Method Skill

§ Skill = 1 – $\frac{\text{Mean Squared Error}}{\text{Mean Squared Anomaly}}$

§ Mean is measured across accident/report years

§ Observations:
- Maximum Skill = 1
- No minimum
- It's all relative

15

Milliman

 Copyright © 2007

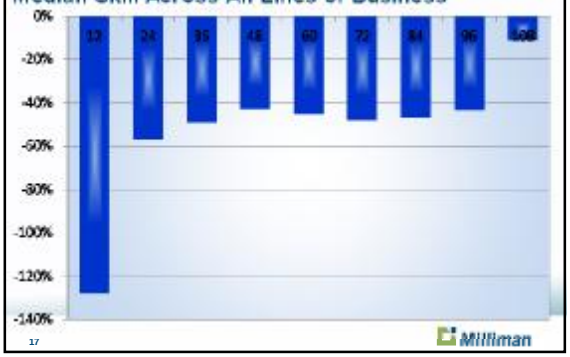
Skill – Advantages and Disadvantages

§ Advantages
- Provides a single number
- Allows for normalization across different insurers
- Calculation has a "credibility" adjustment for % paid

§ Disadvantages
- Does not address bias
- What does skill mean in $?

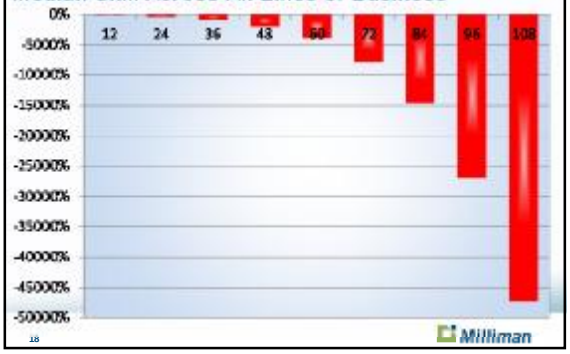
16 Milliman

Incurred Chain Ladder Method
Median Skill Across All Lines of Business



17 Milliman

Industry Loss Ratio Method
Median Skill Across All Lines of Business



18 Milliman

 Copyright © 2007

THE RESULTS

19

Milliman

Results

§ Development Age
- Months of Development 12 through 108

§ Line of Business
- All Schedule P lines

§ Company Size
- Small ($4.2M avg 2010 net annual premium)
- Medium ($17.5M avg premium)
- Large ($350M avg premium)

20

Milliman

Best Performers Mature Evaluations

1. Hindsight IBNR
2. Backward Recursive
3. Incremental Additive – Incurred
4. Bornhuetter-Ferguson – Incurred (Industry Loss Ratio)
5. Case Reserve Chain Ladder

21

Milliman

 Copyright © 2007

Best Performers
Early Evaluations

1. Bornhuetter-Ferguson – Incurred (Industry Loss Ratio)
2. Benktander – Incurred
3. Incremental Additive – Incurred
4. Cape Cod – Incurred
5. Bornhuetter-Ferguson – Incurred (Prior Years' Loss Ratio)

22 Milliman

Worst Performers
Mature Evaluations

30. Frequency / Severity
27. Loss Ratio (All Three Versions)
25. Weighted Brosius – Paid & Incurred
23. Brosius – Paid & Incurred
22. Incremental Multiplicative – Paid

23 Milliman

Worst Performers
Early Evaluations

30. Frequency / Severity
27. Loss Ratio (All Three Versions)
25. Weighted Brosius – Paid & Incurred
24. Claims Closure
23. Incremental Multiplicative – Paid

24 Milliman

 Copyright © 2007

Observations on the Best Performers

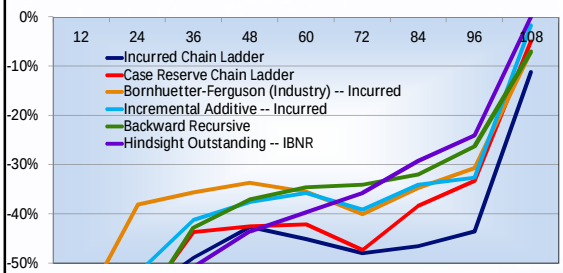
§ Rely at least in part on case reserves

§ Paid does not directly impact unpaid
- (Small impact in Benktander and Cape Cod)

§ Only one in common use
- Bornhuetter-Ferguson

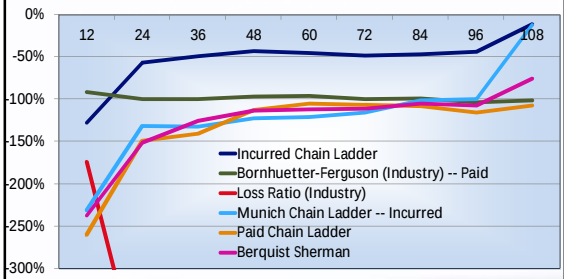
25 Milliman

Median Skill – All Lines of Business



26 Milliman

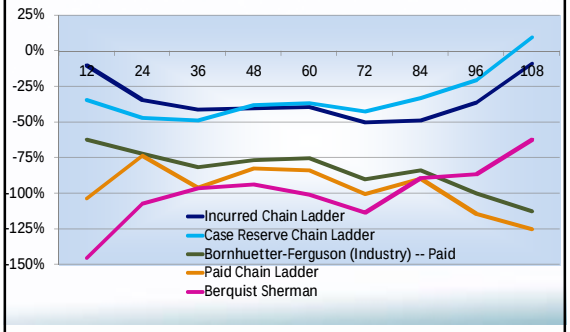
Median Skill – All Lines of Business



27 Milliman

 Copyright © 2007

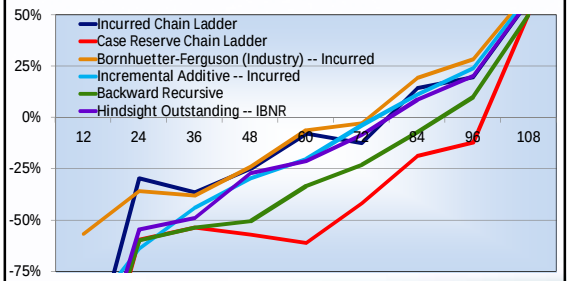
Median Skill – Homeowners/Farmowners



28

Milliman

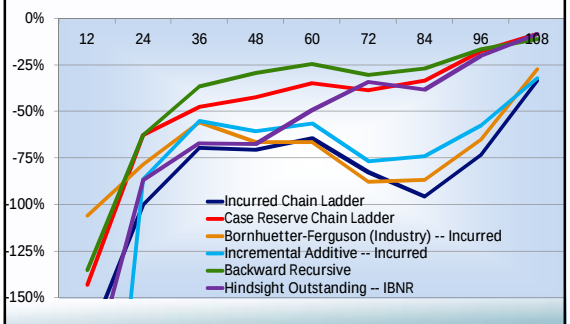
Median Skill – Workers Compensation



29

Milliman

Median Skill – Small Companies

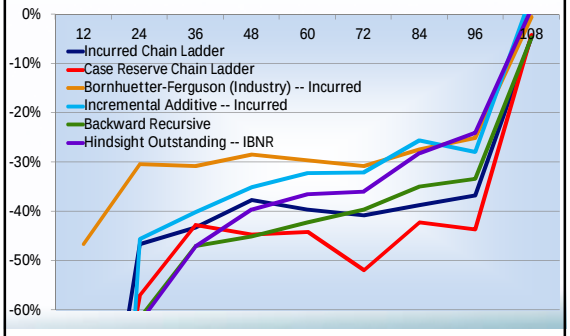


30

Milliman

 Copyright © 2007

Median Skill – Large Companies



31

Milliman

Initial Conclusion

§ Several methods outperform incurred chain ladder:
- Bornhuetter-Ferguson – Incurred
- Benktander – Incurred
- Backward Recursive
- Case Reserve Chain Ladder
- Hindsight Outstanding – IBNR
- Incremental Additive – Incurred

§ So should we be using these methods?
- How significant is the improvement?
- Do we really need all of these methods?

32

Milliman

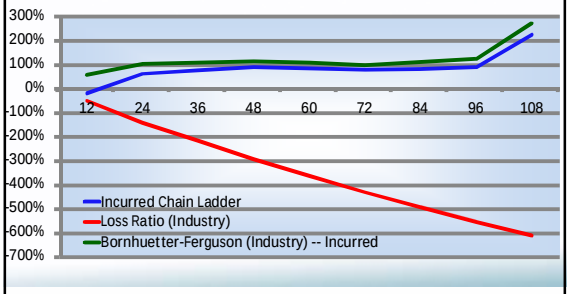
CORRELATION

33

Milliman

 Copyright © 2007

Median Skill – All Lines of Business Logarithmic Scale



34

Milliman

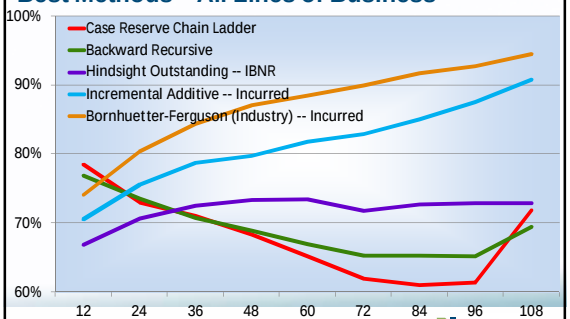
Correlation – Observations

- The less correlated two methods are, the greater the skill of an average of those methods
- Ideal weighting will depend on
  - Correlation
  - Individual method skill
- Also important: lack of bias in methods

35

Milliman

Average Correlation with Incurred Chain Ladder Best Methods – All Lines of Business

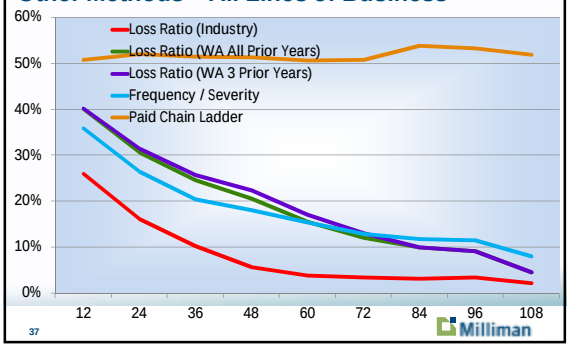


36

Milliman

 Copyright © 2007

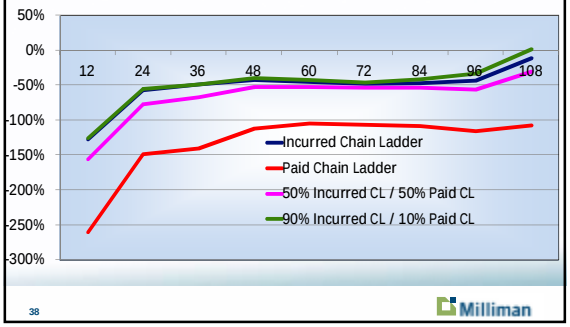
Average Correlation with Incurred Chain Ladder Other Methods – All Lines of Business



37

Milliman

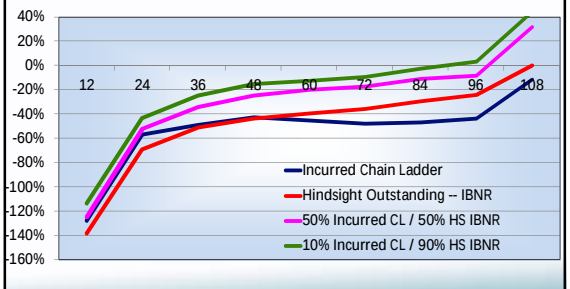
Average of Paid / Incurred Chain Ladders Median Skill – All Lines of Business



38

Milliman

Average of Incurred CL & Hindsight IBNR Median Skill – All Lines of Business



39

Milliman

 Copyright © 2007

SIGNIFICANCE

40

Milliman

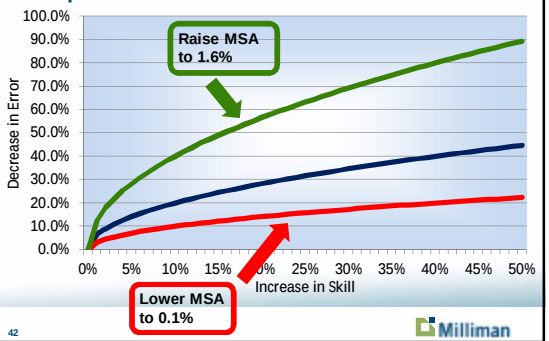
How Significant Is An Increase in Skill? Example

- § 2010 Earned Premium of $60 Million
- § Wtd Avg HS Unpaid Ratio @ 6th Report = 10%
- § HS Unpaid Ratio Ranges from 2% to 31%
- § Anomaly Ranges from -8% to 21%
- § Mean Squared Anomaly = 0.4%

41

Milliman

How Significant Is An Increase in Skill? Example



42

Milliman

 Copyright © 2007

CONCLUSIONS

43

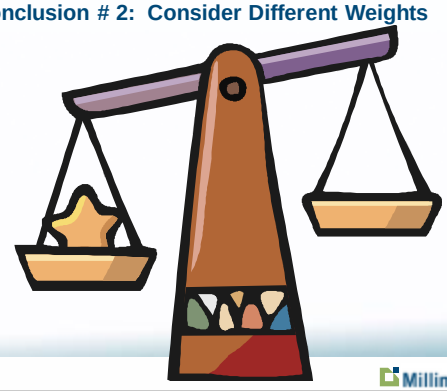
Milliman

Conclusion #1: Consider Different Methods

44

Milliman

Conclusion # 2: Consider Different Weights



45

Milliman

 Copyright © 2007

Questions?

Susan J. Forray, FCAS, MAAA
Principal and Consulting Actuary
Milliman
susan.forray@milliman.com
(262) 796-3328

46

Milliman

 Copyright © 2007