Benchmarking Unpaid Claim Estimates

- **Benchmark:** A standard, or a set of standards, used as a point of reference for evaluating performance or level of quality. Benchmarks may be drawn from a firm's own experience, from the experience of other firms in the industry, or from legal requirements such as environmental regulations.

Source: businessdictionary.com

Milliman 2

Benchmarking Unpaid Claim Estimates

- Have you ever calculated an estimate of unpaid claims?
  - P&C (General) Insurance, any LOB or segment
  - For any reason, reserves, pricing, ERM, etc.
- Have you ever used a benchmark to help with your estimated unpaid claims or range of estimates?

Milliman 3

Benchmarking Unpaid Claim Estimates

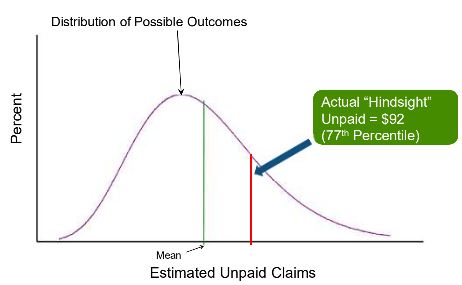
Outline

Milliman 4

Background

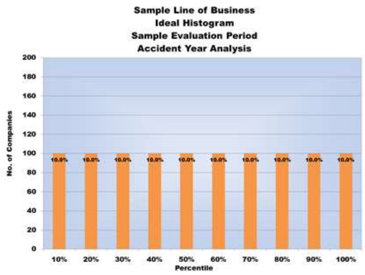
Hindsight Analysis

Hypothetical Unpaid Claim Distribution



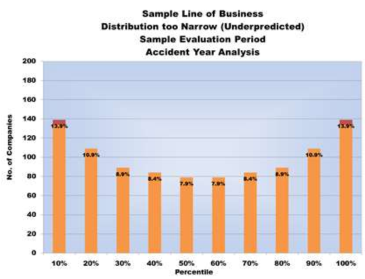
Milliman 6

If Model is Correct…



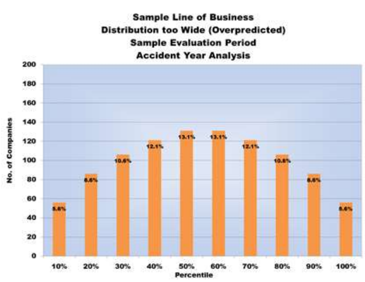
Milliman 7

If Model Underestimates Distribution…



Milliman 8

If Model Overestimates Distribution…



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Background

Prior Research

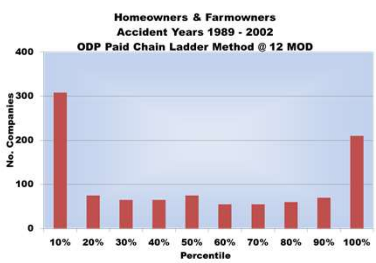
Meyers & Shi

"…study suggests that there might be environmental changes that no single model can identify."

"If this continues to hold, the actuarial profession cannot rely solely on stochastic loss reserve models to manage its reserve risk."

Milliman 11

Leong, Wang & Chen



Leong, Jessica (Weng Kah), Shaun Wang, and Han Chen, "Back-Testing the ODP Bootstrap of the Paid Chain-Ladder Model with Actual Historical Claims Data," CAS E-Forum, Summer 2012, 1-34.

Milliman 12

Leong, Wang & Chen

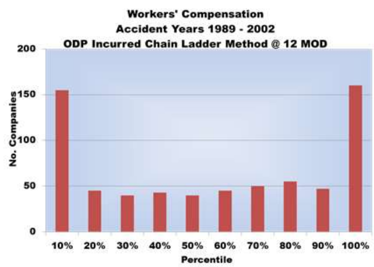
"…the popular ODP bootstrap of the paid chain-ladder method is underestimating reserve risk."

"…the bootstrap model does not consider systemic risk, or, to put it another way, the risk that future trends in the claims environment – such as inflation, trends in tort reform, legislative changes, etc. – may deviate from what we saw in the past."

Leong, Jessica (Weng Kah), Shaun Wang, and Han Chen, "Back-Testing the ODP Bootstrap of the Paid Chain-Ladder Model with Actual Historical Claims Data," CAS E-Forum, Summer 2012, 1-34.

Milliman 13

Leong, Wang & Chen



Leong, Jessica (Weng Kah), Shaun Wang, and Han Chen, "Back-Testing the ODP Bootstrap of the Paid Chain-Ladder Model with Actual Historical Claims Data," CAS E-Forum, Summer 2012, 1-34.

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Leong, Wang & Chen

"…it appears that the incurred bootstrap model is also underestimating the risk of falling in these extreme percentiles."

Note: This is not the same incurred ODP bootstrap model as described in the Shapland Monograph.

Leong, Jessica (Weng Kah), Shaun Wang, and Han Chen, "Back-Testing the ODP Bootstrap of the Paid Chain-Ladder Model with Actual Historical Claims Data," CAS E-Forum, Summer 2012, 1-34.

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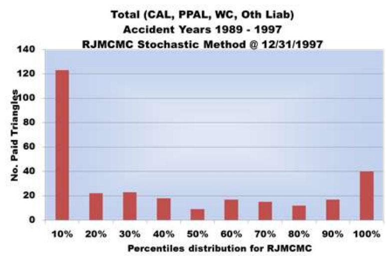
Gremillet & Miehe



Gremillet, Marion, and Pierre Miehe, “Back-Testing the Reversible Jump Markov Chain Monte Carlo & further extensions,” ICA 1-38 (2013).

Milliman 16

Gremillet & Miehe

“…it is core to have adjustments by actuaries prior to running the stochastic methods ‘automatically.’ ”

“Actuary in the box” dream for stochastic reserves valuation not yet happening

Gremillet, Marion, and Pierre Miehe, “Back-Testing the Reversible Jump Markov Chain Monte Carlo & further extensions,” ICA 1-38 (2013).

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Analysis Summary

Comparison of Analyses

Item	Meyers & Shi	Leong, Wang & Chen	Gremillet & Miehe	Shapland
Data	50 Companies	21 (MPL) to 78 (PPAL) Companies	?	1,679 Companies
Evaluations	1	11	5	9
Models	2	2	3	8
Lines of Business	1	9	4	16
Triangle Sets	50	~4,850	296	30,707

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Analysis Details

- **ODP Bootstrap**
  - Paid Chain Ladder
  - Incurred Chain Ladder
  - Paid Bornhuetter-Ferguson
  - Incurred Bornhuetter-Ferguson
  - Paid Cape Cod
  - Incurred Cape Cod
  - Weighted
- **Mack Bootstrap**
  - Paid Chain Ladder

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Analysis Details

- **Beginning Data**
  - NAIC Schedule P – 4,796 Companies (& Groups)
  - Remove all triangles without 10 years of data (Paid, Incurred, etc.)
  - Other data quality tests → "quality data"
  - Test whether next 9 years are identical → "complete data"
- **Test Data**
  - Total of 75,000+ LOBs with "quality data"
  - 1,679 Companies with at least 1 Schedule P LOB of "complete data"
  - Total of 30,707 LOBs with "complete data"
  - 2,104 Companies with at least 2 Schedule P LOBs of "quality data"
  - Approx. 27,000 LOBs with at least 2 for same Company

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Analysis Details

- **Model Output**
  - Accident Year Totals (by Year & All Years Combined)
  - Calendar Year Totals (by Year)
  - Calendar Year Runoff Totals (by Year)
  - Ultimate Loss Ratios (by Year)
  - Incremental Results (by Year and Development Period)
  - Diagnostic Statistics

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Analysis Details

- **Model Options (Tests)**
  - **Test 1 – Defaults**
    - No Tail factors (i.e., 1.000)
    - BF – a priori based on hindsight L/R, No CoV
    - CC – Trend = 2.5%, Decay Ratio = 90%
  - **Test 2 – Selected Limiting of Incrementals**
  - **Test 3 – Selected Limiting & Suggested Heteroscedasticity Groups**

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Model Limitations

Model Limitations

- **Model Risk**
  - Limited to known data
  - A single model can underestimate variability
- **Systemic risk**
  - In addition to model risk
  - A shift in claims environment
- **Need to Understand Assumptions**

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Major Assumption

Bootstrap models (ODP & Mack) assume Chain Ladder projections are unbiased

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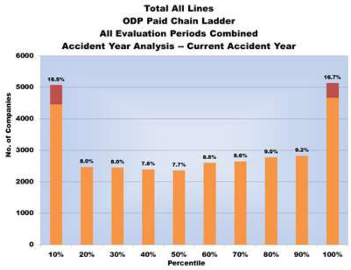
Model Projections

Are they Unbiased?

Comparison of Tests

Test 1



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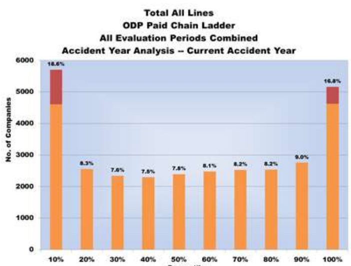
Comparison of Tests

Test 2



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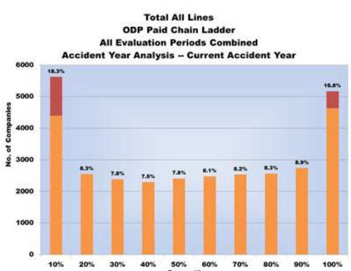
Comparison of Tests

Test 3



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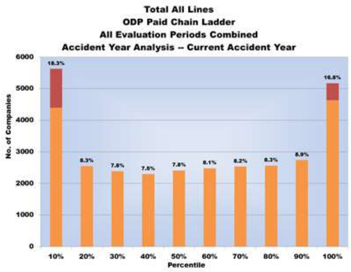
Comparison of Accident Years

Current



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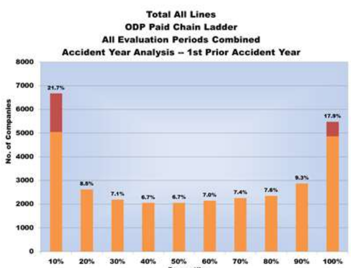
Comparison of Accident Years

1 Prior



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Comparison of Accident Years

2 Prior

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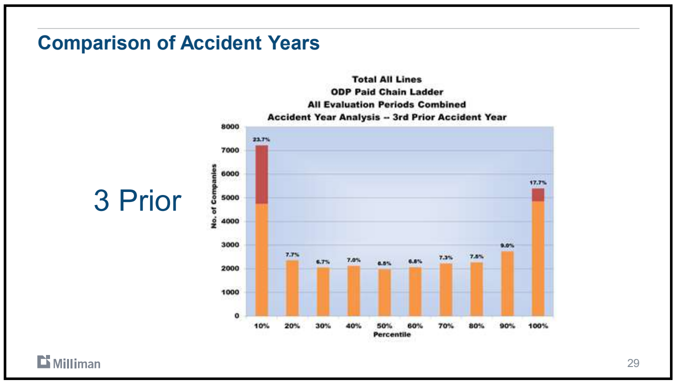
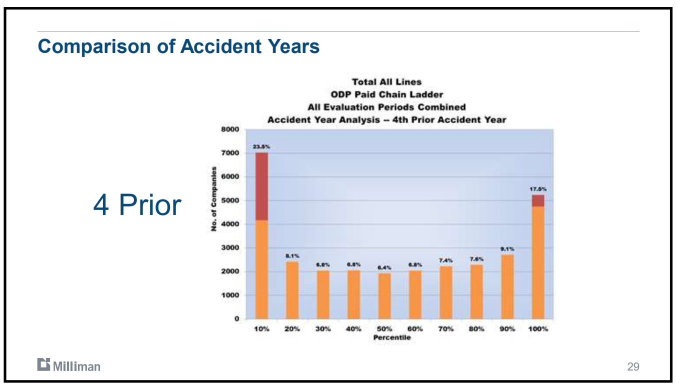
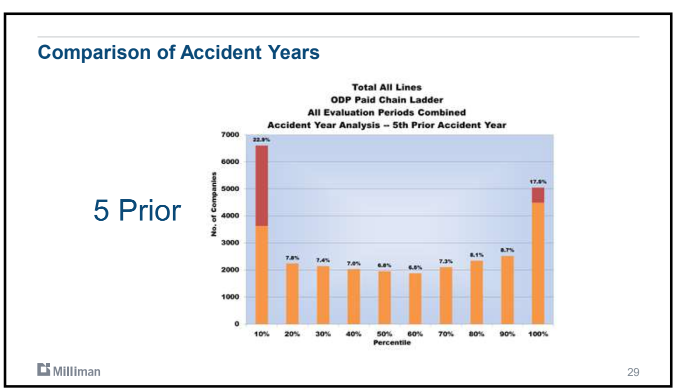
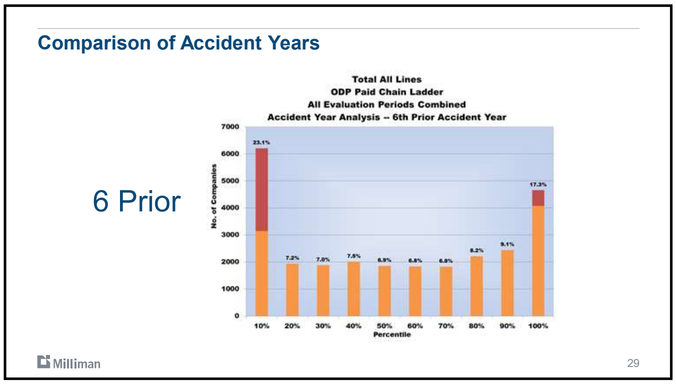
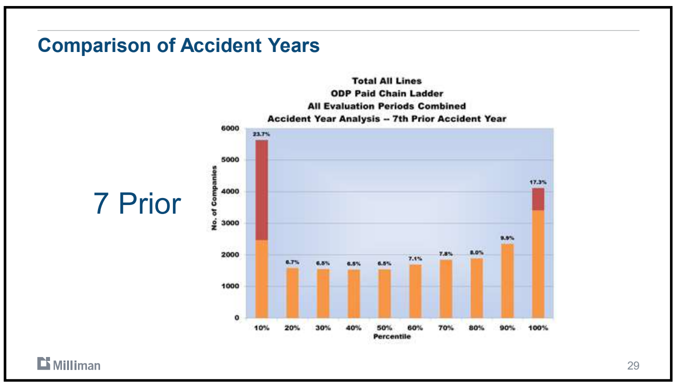
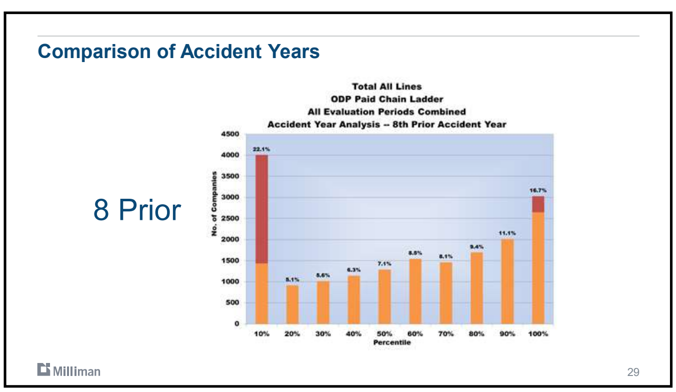

Comparison of Accident Years
3 Prior
Total All Lines
ODP Paid Chain Ladder
All Evaluation Periods Combined
Accident Year Analysis – 3rd Prior Accident Year
No. of Companies
0 1000 2000 3000 4000 5000 6000 7000 8000
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentile
Milliman
29


Comparison of Accident Years
4 Prior
Total All Lines
ODP Paid Chain Ladder
All Evaluation Periods Combined
Accident Year Analysis – 4th Prior Accident Year
No. of Companies
0 1000 2000 3000 4000 5000 6000 7000 8000
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentile
Milliman
29


Comparison of Accident Years
5 Prior
Total All Lines
ODP Paid Chain Ladder
All Evaluation Periods Combined
Accident Year Analysis – 5th Prior Accident Year
No. of Companies
0 1000 2000 3000 4000 5000 6000 7000
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentile
Milliman
29

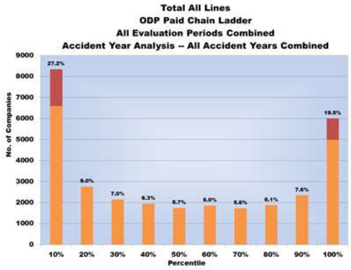

Comparison of Accident Years
6 Prior
Total All Lines
ODP Paid Chain Ladder
All Evaluation Periods Combined
Accident Year Analysis -- 6th Prior Accident Year
No. of Companies
Percentile
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Milliman
29


Comparison of Accident Years
7 Prior
Total All Lines
ODP Paid Chain Ladder
All Evaluation Periods Combined
Accident Year Analysis -- 7th Prior Accident Year
No. of Companies
Percentile
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Milliman
29


Comparison of Accident Years
8 Prior
Total All Lines
ODP Paid Chain Ladder
All Evaluation Periods Combined
Accident Year Analysis -- 8th Prior Accident Year
No. of Companies
Percentile
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Milliman
29

Comparison of Accident Years

ALL



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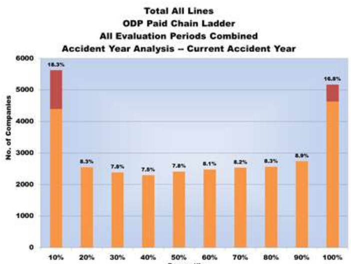
Comparison of Output

Acc Yr



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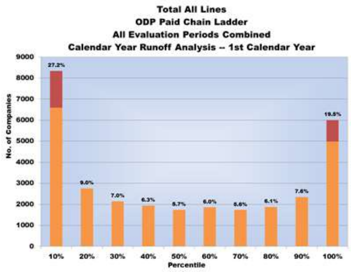
Comparison of Output

Cal Yr

Milliman 30

Comparison of Output

Cal Yr Runoff



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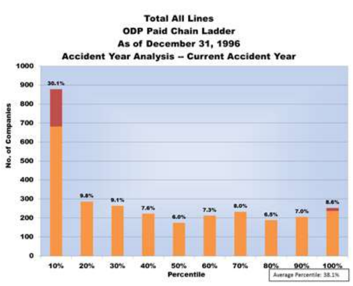
Comparison of Output

Ult L/R

Milliman 30

Comparison of Evaluation Years

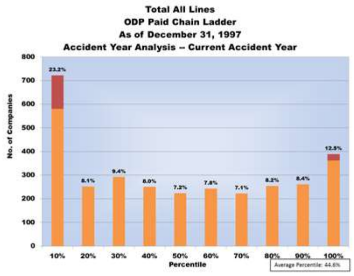
1996



Milliman 31

Comparison of Evaluation Years

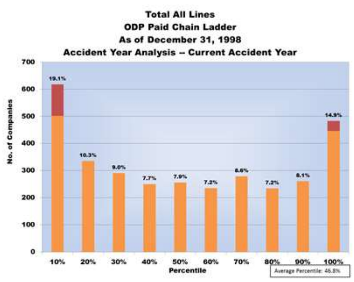
1997



Milliman 31

Comparison of Evaluation Years

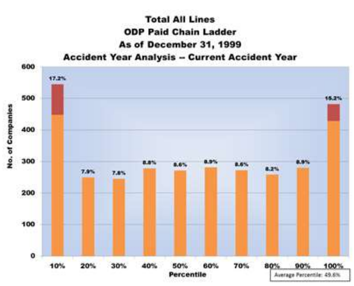
1998



Milliman 31

Comparison of Evaluation Years

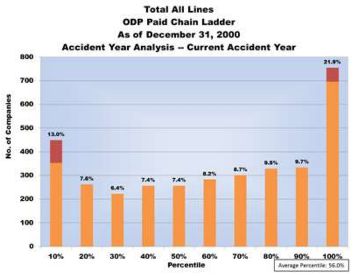
1999



Milliman 31

Comparison of Evaluation Years

2000



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Comparison of Evaluation Years

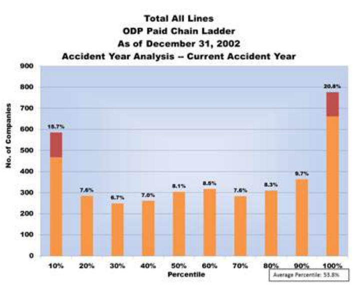
2001

Milliman

31

Comparison of Evaluation Years

2002



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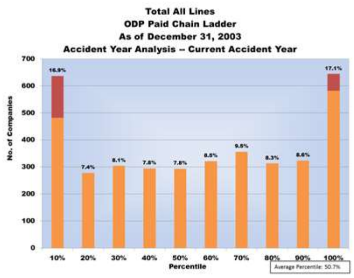
31

Comparison of Evaluation Years

2003



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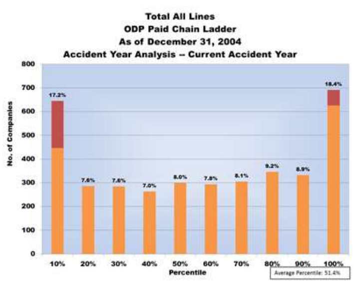
Comparison of Evaluation Years

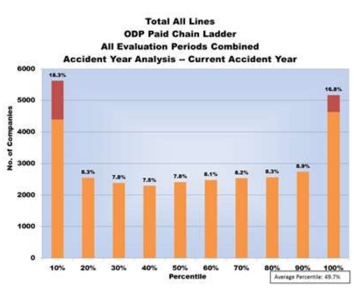
2004



Milliman 31

Comparison of Evaluation Years

ALL



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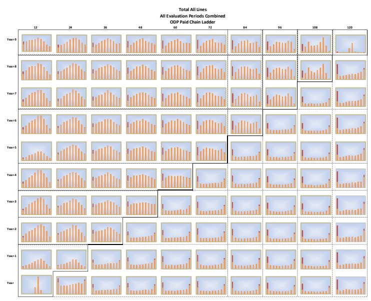
Incrementals



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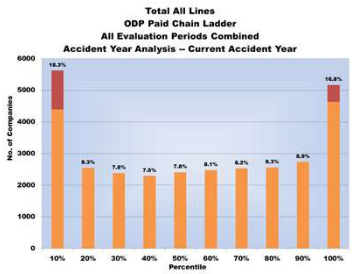
Comparison of Models

ODP
Pd CL



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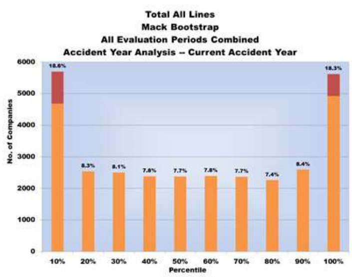
Comparison of Models

Mack
Pd CL



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Comparison of Models

ODP
Inc CL

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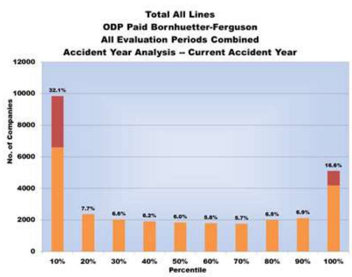
Comparison of Models

ODP
Pd BF



Milliman 33

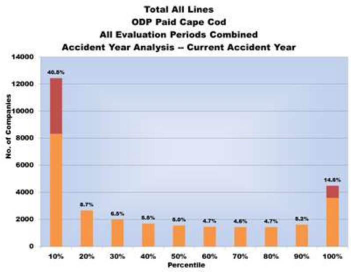
Comparison of Models

ODP
Inc BF

Milliman 33

Comparison of Models

ODP
Pd CC



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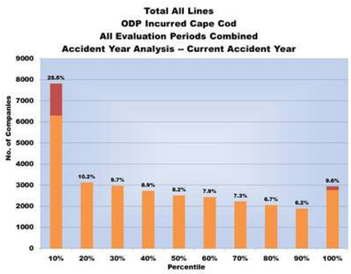
Comparison of Models

ODP
Inc CC



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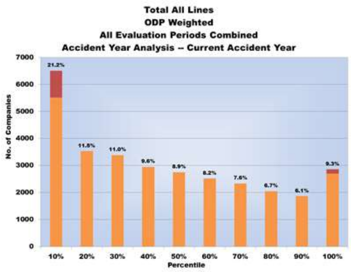
Comparison of Models

ODP
Wgtd



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Proposed Adjustments

Leong, Wang & Chen

- **Systemic Risk Distribution Method**
  - Multiply each simulated bootstrap result by a “systemic” factor
- **Wang Transform Adjustment**
  - Increase the variability of the original unpaid loss distribution
  - Shift the percentiles to account for bias in methods over time
  - Relies on a parameter “Lambda” targeting an ideal histogram

Assumes Model Risk is Systemic!

Based on Hindsight only!

Leong, Jessica (Weng Kah), Shaun Wang, and Han Chen, “Back-Testing the ODP Bootstrap of the Paid Chain-Ladder Model with Actual Historical Claims Data,” CAS E-Forum, Summer 2012, 1-34.

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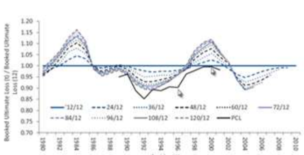
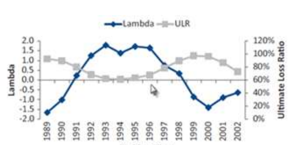
Leong, Wang & Chen





Leong, Jessica (Weng Kah), Shaun Wang, and Han Chen, “Back-Testing the ODP Bootstrap of the Paid Chain-Ladder Model with Actual Historical Claims Data,” CAS E-Forum, Summer 2012, 1-34.

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HDR Adjustment

- Shift distribution by multiplying unpaid claim estimates by the HDR
- Coefficient of variation unchanged
- Additive shift – will not address variance
- Hindsight adjustment, but we are not advocating, just testing how much bias vs. not enough variance

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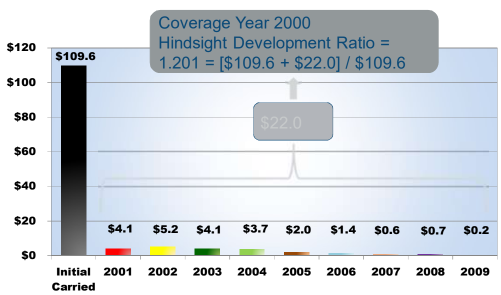
Example – Coverage Year 2000 ($B)



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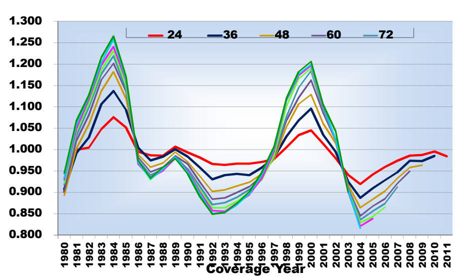
HDR by Evaluation Month



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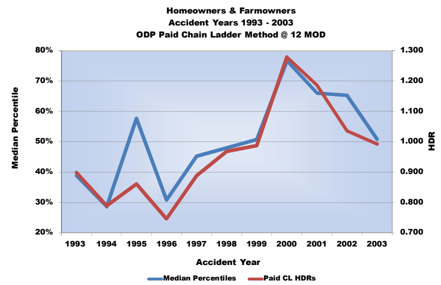
HDRs vs. Median Percentiles



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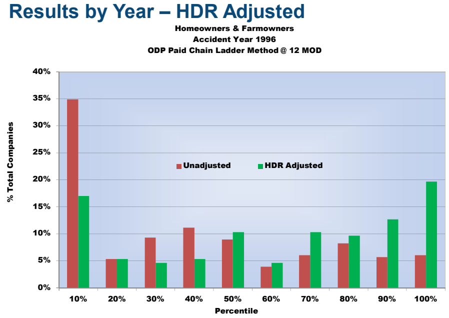
Results by Year – HDR Adjusted



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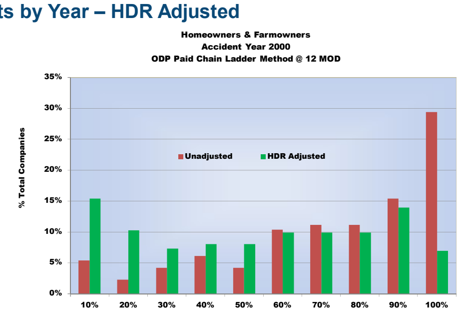
Results by Year – HDR Adjusted



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Conclusions

Conclusions

- **Goal of Ideal Histogram Unrealized by Paid CL Bootstrap**
  - Both ODP Bootstrap and Mack Bootstrap
  - Confirms Other Research
- **Other ODP Bootstraps – Much Closer to Theoretical Ideal**
  - Milliman Incurred models different (Shapland Monograph)
  - Bornhuetter-Ferguson and Cape Cod models
- **Cyclical Bias in Reserve Distributions – Paid and Incurred**
  - Consistent with Deterministic Projections

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Conclusions

- **“Corrections” to Other ODP Models may be Unnecessary**
- **Addressing Model Risk is very important**
  - Can’t “blindly” accept model results
  - Use diagnostics to assess model strengths / weaknesses
  - Implications for weighting
  - Still need to address systemic risks
- **Guidelines (i.e., benchmarks) to Assess Results**
  - Based on hindsight, but forward looking
  - Correlations
- **Distributions by LOB and Premium**

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Claim Variability Guidelines
The Way Forward

Claim Variability Guidelines
Types of Benchmarks

1. Loss Development Patterns
2. Unpaid Claim Distributions
3. Correlation Between Segments

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Claim Variability Guidelines
Loss Development Patterns

- Back-testing output includes VWA factors for all paid data triangles
- Back-testing output includes VWA factors for simulated paid data
- Actual incurred data is part of the data set, but output for incurred simulations is not readily available
- By Schedule P Line of Business, a “distribution” of the patterns were created for both actual and simulated data

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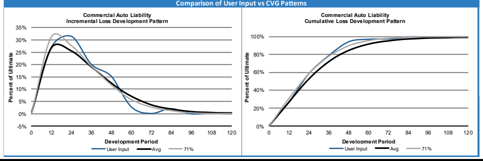
Claim Variability Guidelines

Loss Development Patterns

- As an example of how you might use this information, suppose you are analyzing Commercial Auto data and have selected the following LDF pattern:

User Input Paid Development Pattern:											
Development Periods:		12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120+
User Input ATA Factors:		2.163	1.344	1.193	1.030	1.002	1.023	1.000	1.004	1.000	1.004
Development Age:		12	24	36	48	60	72	84	96	108	120
User Input Pattern:		27.1%	58.6%	78.8%	94.0%	96.8%	97.1%	99.2%	99.3%	99.6%	99.6%
CVG Average Pattern:		26.9%	52.6%	71.8%	84.3%	91.5%	95.2%	97.2%	98.1%	98.7%	99.1%
Best Fit:	71%	55%	71%	74%	89%	81%	57%	67%	54%	56%	47%
CVG:	71%	31.1%	58.8%	78.0%	89.7%	95.5%	98.2%	99.4%	99.8%	99.9%	100.0%
CVG ATA Factors:		1.887	1.328	1.150	1.065	1.028	1.012	1.004	1.001	1.000	1.000

Comparison of User Input vs CVG Patterns



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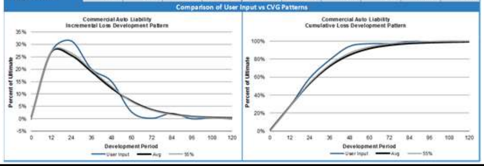
Claim Variability Guidelines

Loss Development Patterns

- Overall the 71st percentile fits the best, but this varies by development age. Alternatively, the 55th percentile fits better in the early and later ages:

User Input Paid Development Pattern:											
Development Periods:		12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120+
User Input ATA Factors:		2.163	1.344	1.193	1.030	1.002	1.023	1.000	1.004	1.000	1.004
Development Age:		12	24	36	48	60	72	84	96	108	120
User Input Pattern:		27.1%	58.6%	78.8%	94.0%	96.8%	97.1%	99.2%	99.3%	99.6%	99.6%
CVG Average Pattern:		26.9%	52.6%	71.8%	84.3%	91.5%	95.2%	97.2%	98.1%	98.7%	99.1%
Best Fit:	71%	55%	71%	74%	89%	81%	57%	67%	54%	56%	47%
CVG:	55%	27.1%	53.6%	73.4%	86.5%	93.4%	96.9%	98.6%	99.3%	99.6%	99.8%
CVG ATA Factors:		1.982	1.369	1.178	1.080	1.037	1.018	1.008	1.003	1.002	1.002

Comparison of User Input vs CVG Patterns



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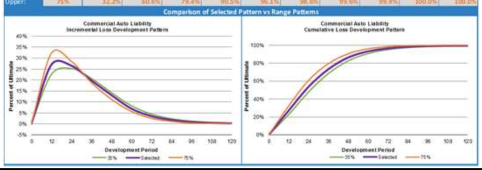
Claim Variability Guidelines

Loss Development Patterns

- To develop a range, you could then calculate new unpaid claim estimates by selecting development patterns +/- 20% from the best fit:

Selected Paid Development Pattern:											
Selection Criteria:		CVG	CVG	CVG	CVG	CVG	CVG	CVG	CVG	CVG	User Input
Default ATA Factors:		1.982	1.369	1.178	1.080	1.037	1.018	1.008	1.003	1.002	1.004
User Override:											
Selected ATA Factors:		1.982	1.369	1.178	1.080	1.037	1.018	1.008	1.003	1.002	1.004
Selected Pattern:		27.0%	53.6%	73.3%	86.4%	93.3%	96.7%	98.4%	99.2%	99.5%	99.6%
Range:	20%										
Lower:	35%	22.5%	47.7%	68.3%	82.5%	90.6%	95.0%	97.3%	98.5%	99.2%	99.4%
Upper:	75%	32.2%	60.6%	79.4%	90.5%	96.1%	98.6%	99.6%	99.9%	100.0%	100.0%

Comparison of Selected Pattern vs Range Patterns



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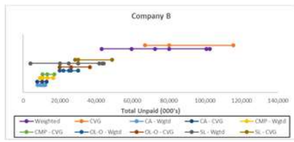
Claim Variability Guidelines
Loss Development Patterns

- The range from the selected benchmark patterns can then be compared to the estimates from a traditional range:



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Claim Variability Guidelines
Unpaid Claim Distributions

- For each Schedule P LOB, the back-testing results contain thousands of simulated distributions for companies of all different sizes
- Regression models were used to fit the distributions by premium volume for each of the Acc Yr, Cal Yr, Cal Yr Runoff, and Loss Ratio distributions
- Fitted results were smoothed to be consistent between distribution types and to conform with statistical properties

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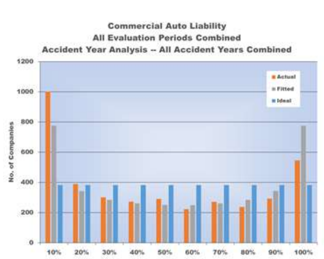
Claim Variability Guidelines
Unpaid Claim Distributions

- Variance Adjustment Factors can be used to correct for back-testing results
- Separate variance adjustments factors for Loss Ratio distributions
- For example, this is the Acc Yr adjustment for Commercial Auto
- “Fitted” results still appear to under-estimate, but this is reserve cycle affect



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Claim Variability Guidelines

Unpaid Claim Distributions

- The regression model adjusts assumptions to fit statistical properties.
- For example, consider smaller vs larger number of exposures:

Small Insurer

Commercial Auto Liability Accident Year Guidelines (US$ 000's)					
Acc Yr	Premium	L/R	Mean	Std Dev	CoV
2008	5,115	75.3%	17	63	369.8%
2009	5,302	77.1%	42	112	268.7%
2010	5,427	79.4%	95	203	213.1%
2011	5,508	81.7%	196	308	157.3%
2012	5,668	82.5%	404	498	123.4%
2013	5,907	82.0%	820	737	89.9%
2014	6,277	79.2%	1,532	1,019	66.5%
2015	6,780	74.9%	2,719	1,640	60.3%
2016	7,214	73.8%	4,278	2,401	56.1%
Total	**53,197**	**78.3%**	**10,102**	**3,654**	**36.2%**

Large Insurer

Commercial Auto Liability Accident Year Guidelines (US$ 000's)					
Acc Yr	Premium	L/R	Mean	Std Dev	CoV
2008	40,918	75.3%	131	284	216.4%
2009	42,415	77.1%	323	464	143.5%
2010	43,419	79.4%	735	838	114.0%
2011	44,064	81.7%	1,516	1,223	80.6%
2012	45,343	82.5%	3,124	2,067	66.2%
2013	47,256	82.0%	6,344	3,409	53.7%
2014	50,215	79.2%	11,850	5,250	44.3%
2015	54,236	74.9%	21,034	8,442	40.1%
2016	57,710	73.8%	33,093	12,465	37.7%
Total	**425,576**	**78.3%**	**78,152**	**17,681**	**22.6%**

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Claim Variability Guidelines

Unpaid Claim Distributions

- The regression model allows for other customizations.
- For example, consider a faster development pattern:

Average Development

Commercial Auto Liability Accident Year Guidelines (US$ 000's)					
Acc Yr	Premium	L/R	Mean	Std Dev	CoV
2008	20,459	75.3%	66	157	238.9%
2009	21,207	77.1%	162	263	161.9%
2010	21,709	79.4%	369	475	128.6%
2011	22,032	81.7%	762	700	91.9%
2012	22,671	82.5%	1,570	1,171	74.6%
2013	23,628	82.0%	3,188	1,882	59.0%
2014	25,108	79.2%	5,954	2,832	47.6%
2015	27,118	74.9%	10,568	4,556	43.1%
2016	28,855	73.8%	16,627	6,715	40.4%
Total	**212,788**	**78.3%**	**39,266**	**9,666**	**24.6%**

Faster Development

Commercial Auto Liability Accident Year Guidelines (US$ 000's)					
Acc Yr	Premium	L/R	Mean	Std Dev	CoV
2008	20,459	75.3%	2	25	1506.9%
2009	21,207	77.1%	18	79	430.9%
2010	21,709	79.4%	69	173	249.2%
2011	22,032	81.7%	275	360	131.0%
2012	22,671	82.5%	794	721	90.8%
2013	23,628	82.0%	2,029	1,320	65.0%
2014	25,108	79.2%	4,481	2,227	49.7%
2015	27,118	74.9%	8,926	3,945	44.2%
2016	28,855	73.8%	15,589	6,351	40.7%
Total	**212,788**	**78.3%**	**32,182**	**8,202**	**25.5%**

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Claim Variability Guidelines

Unpaid Claim Distributions

- The regression model accommodates international use.
- For example, consider a European insurer with the same development pattern:

US Insurer

Commercial Auto Liability Accident Year Guidelines (US$ 000's)					
Acc Yr	Premium	L/R	Mean	Std Dev	CoV
2008	20,459	75.3%	66	157	238.9%
2009	21,207	77.1%	162	263	161.9%
2010	21,709	79.4%	369	475	128.6%
2011	22,032	81.7%	762	700	91.9%
2012	22,671	82.5%	1,570	1,171	74.6%
2013	23,628	82.0%	3,188	1,882	59.0%
2014	25,108	79.2%	5,954	2,832	47.6%
2015	27,118	74.9%	10,568	4,556	43.1%
2016	28,855	73.8%	16,627	6,715	40.4%
Total	**212,788**	**78.3%**	**39,266**	**9,666**	**24.6%**

European Insurer

Commercial Auto Liability Accident Year Guidelines (€ 000's)					
Acc Yr	Premium	L/R	Mean	Std Dev	CoV
2008	20,459	75.3%	66	161	244.5%
2009	21,207	77.1%	163	271	166.4%
2010	21,709	79.4%	370	489	132.2%
2011	22,032	81.7%	763	722	94.7%
2012	22,671	82.5%	1,572	1,205	76.6%
2013	23,628	82.0%	3,191	1,926	60.4%
2014	25,108	79.2%	5,961	2,884	48.4%
2015	27,118	74.9%	10,581	4,638	43.8%
2016	28,855	73.8%	16,647	6,834	41.1%
Total	**212,788**	**78.3%**	**39,313**	**9,870**	**25.1%**

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Claim Variability Guidelines

Unpaid Claim Distributions

- The regression model includes four different types of results:

Acc Yr

Commercial Auto Liability Accident Year Guidelines (US$ 000's)					
Acc Yr	Premium	L/R	Mean	Std Dev	CoV
2008	20,459	75.3%	66	157	238.9%
2009	21,207	77.1%	162	263	161.9%
2010	21,709	79.4%	369	475	128.6%
2011	22,032	81.7%	762	700	91.9%
2012	22,671	82.5%	1,570	1,171	74.6%
2013	23,628	82.0%	3,188	1,882	59.0%
2014	25,108	79.2%	5,954	2,832	47.6%
2015	27,118	74.9%	10,568	4,556	43.1%
2016	28,855	73.8%	16,627	6,715	40.4%
Total	212,788	78.3%	39,266	9,666	24.6%

Cal Yr

Commercial Auto Liability Calendar Year Guidelines (US$ 000's)					
Cal Yr	Premium	L/R	Mean	Std Dev	CoV
2017	212,788	78.3%	16,042	4,772	29.7%
2018	192,329	78.6%	10,398	3,655	35.2%
2019	171,122	78.8%	6,136	2,665	43.4%
2020	149,412	78.7%	3,337	1,943	58.2%
2021	127,380	78.2%	1,716	1,274	74.3%
2022	104,709	77.2%	879	882	100.4%
2023	81,081	75.9%	435	599	137.5%
2024	55,973	74.3%	224	358	159.8%
2025	28,855	73.8%	99	227	230.0%
Total			39,266	9,666	24.6%

Cal Yr Runoff

Commercial Auto Liability Calendar Year Runoff Guidelines (US$ 000's)					
Cal Yr End	Premium	L/R	Mean	Std Dev	CoV
2016	212,788	78.3%	39,266	9,666	24.6%
2017	192,329	78.6%	23,224	6,788	29.2%
2018	171,122	78.8%	12,826	4,679	36.5%
2019	149,412	78.7%	6,690	3,166	47.3%
2020	127,380	78.2%	3,353	2,033	60.6%
2021	104,709	77.2%	1,637	1,316	80.4%
2022	81,081	75.9%	758	831	109.6%
2023	55,973	74.3%	323	459	142.1%
2024	28,855	73.8%	99	227	230.0%

Loss Ratio

Commercial Auto Liability Loss Ratio Guidelines (US$ 000's)				
Acc Yr	Premium	Mean	Std Dev	CoV
2007	19,719	73.8%	10.1%	13.6%
2008	20,459	75.3%	10.7%	14.2%
2009	21,207	77.1%	11.4%	14.8%
2010	21,709	79.4%	12.2%	15.3%
2011	22,032	81.7%	12.1%	14.9%
2012	22,671	82.5%	13.7%	16.6%
2013	23,628	82.0%	13.5%	16.4%
2014	25,108	79.2%	13.6%	17.2%
2015	27,118	74.9%	13.8%	18.4%
2016	28,855	73.8%	15.4%	20.9%

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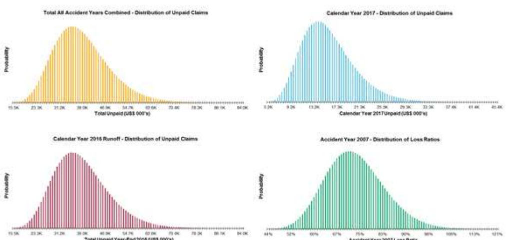
Claim Variability Guidelines

Unpaid Claim Distributions

- In Excel, these are easy to graph:

Acc Yr

Cal Yr



Cal Yr Runoff

Loss Ratio

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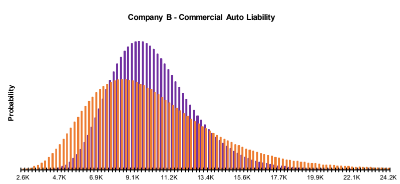
Claim Variability Guidelines

Unpaid Claim Distributions

- Compared to “single” model approach, the typical estimate has less variance than the benchmark:



	Mean	Std Dev	CoV	75.0%	90.0%	95.0%	99.5%
ODP Pd CL Results	10,428	2,473	23.7%	11,881	13,694	14,909	18,536
CVG Benchmark	10,428	3,878	37.2%	12,460	15,502	17,668	24,700

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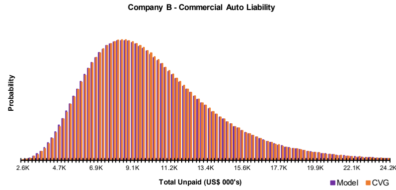
Claim Variability Guidelines
Unpaid Claim Distributions

- Compared to "multiple" model approach, the typical estimate closer to the benchmark:



	Mean	Std Dev	CoV	75.0%	90.0%	95.0%	99.5%
Model Results*	10,428	3,911	37.5%	12,471	15,543	17,733	24,859
CVG Benchmark	10,428	3,878	37.2%	12,460	15,502	17,668	24,700

** Model Results based on weighting of 4 different models.*

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Claim Variability Guidelines
Correlation Between Segments

- Back-testing output includes correlation statistics between all pairs of LOBs within a company (i.e., if there was more than one 'complete' LOB)
- Output includes both paid and incurred, before and after optimal hetero adjustments
- The mean and std dev (unweighted and weighted) for all specific pairs (i.e., between two specific LOBs) was measured
- Weights based on 1 minus P-Value, since the lower the P-Value the more statistically significant the correlation

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Claim Variability Guidelines
Correlation Between Segments

- For example, consider the weighted results for 5 LOBs using 1996 data:

Means

Paid After Hetero Adjustments (1996 Only)
Mean Values [Wgtd Values (Using 1 - PValue)]

	MPL-O	HO	WC	CA	PPA
MPL-O	100%	0.0%	-16.2%	5.9%	-1.7%
HO	0.0%	100%	5.4%	9.5%	16.7%
WC	-16.2%	5.4%	100%	17.1%	18.9%
CA	5.9%	9.5%	17.1%	100%	19.3%
PPA	-1.7%	16.7%	18.9%	19.3%	100%

Standard Deviations

Paid After Hetero Adjustments (1996 Only)
Standard Deviation Values [Wgtd Values (Using 1 - PValue)]

	MPL-O	HO	WC	CA	PPA
MPL-O		14.0%	14.6%	18.8%	18.6%
HO	14.0%		23.6%	22.9%	22.9%
WC	14.6%	23.6%		26.6%	26.0%
CA	18.8%	22.9%	26.6%		27.1%
PPA	18.6%	22.9%	26.0%	27.1%	

Counts

Paid After Hetero Adjustments (1996 Only)
Count of Pairs

	MPL-O	HO	WC	CA	PPA
MPL-O		57	62	59	48
HO	57		618	757	851
WC	62	618		688	570
CA	59	757	688		784
PPA	48	851	570	784	

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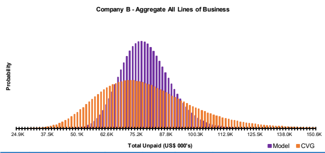
Claim Variability Guidelines

Correlation Between Segments

- Consistent with individual segments, aggregates using a "single" model approach tend to be narrower than benchmarks:



	Mean	Std Dev	CoV	75.0%	90.0%	95.0%	99.5%
ODP Pd CL Results*	80,159	10,504	13.1%	86,792	93,946	98,507	111,231
CVG Benchmark	80,159	20,222	25.2%	91,900	106,857	116,949	147,377
TVaR Estimates							
ODP Pd CL Results*				94,017	100,081	104,153	116,002
CVG Benchmark				107,420	120,852	130,320	159,855
Capital Required							
ODP Pd CL Results*				13,858	19,922	23,994	35,843
CVG Benchmark				27,261	40,693	50,161	79,696

** Using only the ODP Bootstrap model for Paid data for each LOB.*

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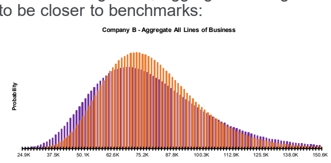
Claim Variability Guidelines

Correlation Between Segments

- Consistent with individual segments, aggregates using a "multiple" model approach tend to be closer to benchmarks:



	Mean	Std Dev	CoV	75.0%	90.0%	95.0%	99.5%
Model Results*	80,159	24,749	30.9%	93,879	112,752	125,815	166,623
CVG Benchmark	80,159	20,222	25.2%	91,900	106,857	116,949	147,377
TVaR Estimates							
Model Results*				113,720	131,133	143,675	184,053
CVG Benchmark				107,420	120,852	130,320	159,855
Capital Required							
Model Results*				33,561	50,974	63,516	103,894
CVG Benchmark				27,261	40,693	50,161	79,696

** Model Results based on weighting of 4 different models for each LOB.*

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Claim Variability Guidelines

Other Potential Uses

- Calculating average durations for future cash flows
- Calculating reserve risk margins based on the expected unpaid claim runoff
- Assessing the variance parameter for a priori loss ratio assumptions in models
- Other uses which are only limited by your imagination

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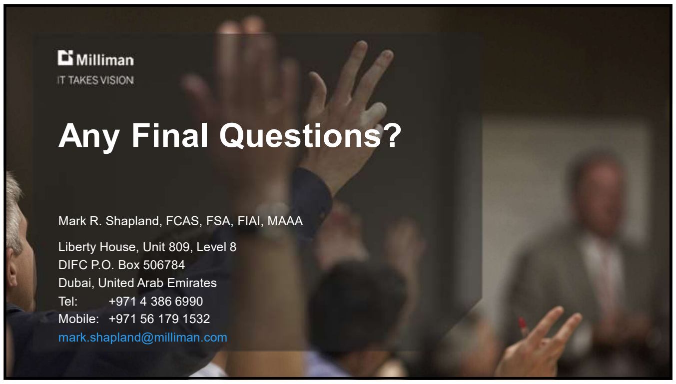
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IT TAKES VISION
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