Basic Reserving: Estimating the Liability for Unpaid Claims

September 15, 2014
Derek Freihaut, FCAS, MAAA
John Wade, ACAS, MAAA
Pinnacle Actuarial Resources, Inc.

Loss Reserve

- **What is a loss reserve?**

  Amount necessary to settle unpaid claims

- **Why are loss reserves important?**

  Accurate evaluation of financial condition and underwriting income

Components of a Reserve

- Case reserves
- Incurred but not reported ("IBNR") reserves
  - Claims incurred but not yet reported
  - Claims reported but not yet recorded
  - Future increases in case reserves
  - Closed claims that reopen in the future

Case Reserve Basics

- Estimated by a claim adjuster
- Based on the details of the claim
- Various reserving philosophies
  - Most likely settlement value (mode)
  - Expected value of settlement (mean)
  - Maximum settlement value
  - Etc.

Case Reserve Issues

- Loss adjustment expenses
- Impact of inflation
- Recoveries from salvage and subrogation
- Recoveries from reinsurance

Hypothetical Claim Background

- Auto liability insurance

- Policy period: April 1, 2012 to March 30, 2013

- Accident date: December 4, 2012

- Date of claim report: January 15, 2013

Hypothetical Claim Transactions – Part 1

Date	Transaction	Reported Claim Value	Cumulative Paid to Date
Jan. 15, 2013	Case reserve of $10,000 established	$10,000	$0
Mar. 22, 2013	$2,500 payment for medical costs; Case reserve reduced to $7,500	$10,000	$2,500
Apr. 18, 2013	$500 payment to independent adjuster; No change to case reserve	$10,500	$3,000
Oct. 14, 2014	Case reserve increased from $7,500 to $50,000	$53,000	$3,000
Dec. 18, 2014	Claim settled with $25,000 payment for lost wages and additional medical costs; Case reserve decreased to $0	$28,000	$28,000

Hypothetical Claim Transactions – Part 2

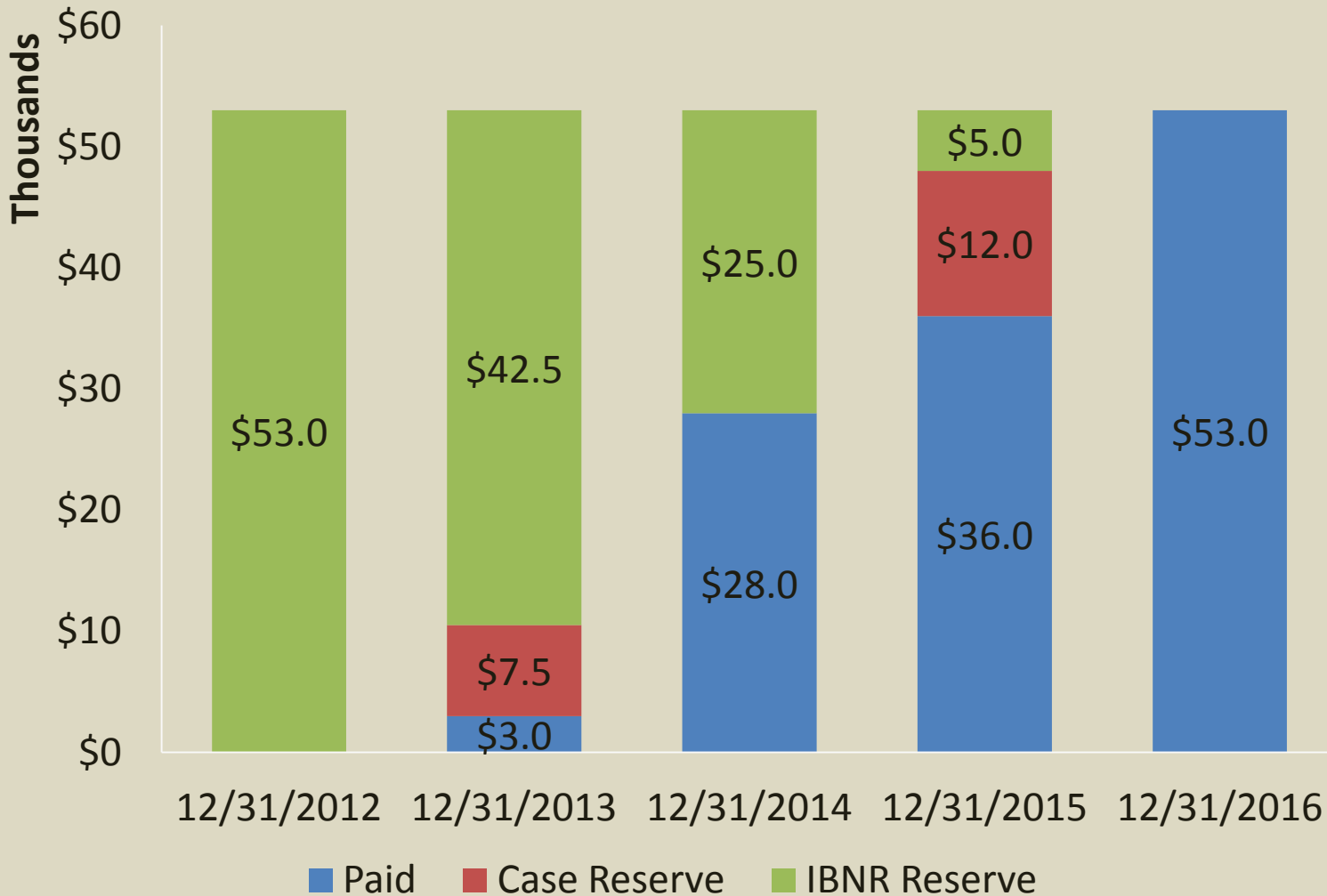| Date	Transaction	Reported Claim Value	Cumulative Paid to Date
Sep. 3, 2015	Claim reopened with case reserve of $15,000 for legal defense costs and $5,000 for future payments to claimant	$48,000	$28,000
Dec. 8, 2015	Payment of $8,000 for legal costs; Case reserve for defense costs reduced to $7,000	$48,000	$36,000
Aug. 30, 2016	Final payment to claimant of an additional $9,000; Case reserve for payment to claimant reduced to $0	$52,000	$45,000
Sep. 15, 2016	Final payment for defense costs of an additional $8,000; Case reserve reduced to $0	$53,000	$53,000

The Problem

- Policy was sold in early 2012
- Claim isn't fully paid until late 2016
- How does the company know if its business is profitable?

Hypothetical Claim
Year-End Losses

	12/31/2012	12/31/2013	12/31/2014	12/31/2015	12/31/2016
IBNR Reserve	$53.0	$42.5	$25.0	$5.0	
Case Reserve		$7.5		$12.0	
Paid		$3.0	$28.0	$36.0	$53.0

Legend: ■ Paid   ■ Case Reserve   ■ IBNR Reserve

Interested Parties

- **Company management**
  Which business segments are the most/least profitable?

- Investors
  How profitable is the company?

- Regulators
  Does the company have sufficient funds available to meet its obligations to policyholders?

Basic Methods

Expected Loss Ratio
- Single Accident Year

- Premium Earned During 2012 = $5 million

- Expected loss ratio = 80%

- Expected losses = $5 million x 80%

    = $4 million

- Total payments as of 12/31/2012

    = $1.5 million

- Total reserves as of 12/31/2012

    = $4 million - $1.5 million

    = $2.5 million

Expected Loss Ratio
- Multiple Years

(1) Accident Year	(2) Earned Premium	(3) Expected Loss Ratio	(4) = (2) x (3) Expected Ultimate Loss	(5) Paid Loss as of 12/31/12	(6) = (4) − (5) Estimated Loss Reserve
2005	14,784	75%	11,088	10,852	236
2006	17,468	75%	13,101	15,045	(1,944)
2007	19,550	75%	14,663	15,878	(1,215)
2008	21,243	75%	15,932	14,967	965
2009	24,003	75%	18,002	15,425	2,577
2010	24,866	75%	18,649	11,836	6,813
2011	25,843	75%	19,382	5,609	13,773
2012	27,487	75%	20,615	1,406	19,209
Total	**175,244**		**131,433**	**91,018**	**40,415**

Expected Loss Ratio
Pros and Cons

- Strengths
  - Simple calculation, easy to explain
  - Minimal data requirements
  - Not sensitive to data fluctuations
- Weaknesses
  - Not responsive to data fluctuations
  - Not responsive to changes in risk environment
  - No accounting for inherent uncertainty in the expected loss ratio – the key parameter

Paid Loss Development Data
Accounting Configuration

Accident Year	Accident Year Paid Losses (in $000s) Cumulative Totals as of 12/31/XX							
	2005	2006	2007	2008	2009	2010	2011	2012
2005	696	2,785	5,262	8,178	9,522	10,604	10,803	10,852
2006		776	3,907	8,383	12,748	14,161	14,805	15,045
2007			1,058	4,344	8,501	11,912	15,148	15,878
2008				1,106	4,589	7,929	12,618	14,967
2009					1,230	4,829	10,355	15,425
2010						1,281	5,696	11,836
2011							1,217	5,609
2012								1,406

Paid Loss Development Data
Actuarial Configuration

Accident Year	Accident Year Paid Losses (in $000s) Cumulative Totals by Development Age in Months							
	12	24	36	48	60	72	84	96
2005	696	2,785	5,262	8,178	9,522	10,604	10,803	10,852
2006	776	3,907	8,383	12,748	14,161	14,805	15,045	
2007	1,058	4,344	8,501	11,912	15,148	15,878		
2008	1,106	4,589	7,929	12,618	14,967			
2009	1,230	4,829	10,355	15,425				
2010	1,281	5,696	11,836					
2011	1,217	5,609						
2012	1,406							

Loss Development Factor From 12 Months to 24 Months

Accident Year	Cumulative Paid at 12 Months	Cumulative Paid at 24 Months	Loss Development Factor
2005	696	2,785	4.002 = 2,785 / 696
2006	776	3,907	5.032 = 3,907 / 776
2007	1,058	4,344	4.107 = 4,344 / 1,058
2008	1,106	4,589	4.151 = 4,589 / 1,106
2009	1,230	4,829	3.926 = 4,829 / 1,230
2010	1,281	5,696	4.445 = 5,696 / 1,281
2011	1,217	5,609	4.611 = 5,609 / 1,217
Total	7,364	31,759	4.313 = 31,759 / 7,364
2012	**1,406**	**???**	**???**

Loss Development Factor From 12 Months to 24 Months

Accident Year	Cumulative Paid at 12 Months	Cumulative Paid at 24 Months	Loss Development Factor
2005	696	2,785	4.002 = 2,785 / 696
2006	776	3,907	5.032 = 3,907 / 776
2007	1,058	4,344	4.107 = 4,344 / 1,058
2008	1,106	4,589	4.151 = 4,589 / 1,106
2009	1,230	4,829	3.926 = 4,829 / 1,230
2010	1,281	5,696	4.445 = 5,696 / 1,281
2011	1,217	5,609	4.611 = 5,609 / 1,217
Total	7,364	31,759	4.313 = 31,759 / 7,364
2012	1,406	**1,406 x 4.300 = 6,046**	**4.300**

Paid Loss Development Data
Actuarial Configuration

Accident Year	Accident Year Paid Losses (in $000s) Cumulative Totals by Development Age in Months							
	12	24	36	48	60	72	84	96
2005	696	2,785	5,262	8,178	9,522	10,604	10,803	10,852
2006	776	3,907	8,383	12,748	14,161	14,805	15,045	
2007	1,058	4,344	8,501	11,912	15,148	15,878		
2008	1,106	4,589	7,929	12,618	14,967			
2009	1,230	4,829	10,355	15,425				
2010	1,281	5,696	11,836					
2011	1,217	5,609						
2012	1,406	**6,046**						

Paid Loss Development Data
Loss Development Factor Selection

Accident Year	12-24	24-36	36-48	58-60	60-72	72-84	84-96	96-Ult
2005	4.002	1.889	1.554	1.164	1.114	1.019	1.005	
2006	5.032	2.146	1.521	1.111	1.045	1.016		
2007	4.107	1.957	1.401	1.272	1.048			
2008	4.151	1.728	1.591	1.186				
2009	3.926	2.144	1.490					
2010	4.445	2.078						
2011	4.611							
2012								
Wtd Avg	4.313	1.999	1.506	1.184	1.063	1.017	1.005	
Selected	4.300	2.000	1.500	1.185	1.065	1.017	1.005	???

Paid Loss Development Data
Loss Development Factor Projection

Accident Year	12-24	24-36	36-48	58-60	60-72	72-84	84-96	96-Ult
2005	4.002	1.889	1.554	1.164	1.114	1.019	1.005	???
2006	5.032	2.146	1.521	1.111	1.045	1.016	**1.005**	???
2007	4.107	1.957	1.401	1.272	1.048	**1.017**	**1.005**	???
2008	4.151	1.728	1.591	1.186	**1.065**	**1.017**	**1.005**	???
2009	3.926	2.144	1.490	**1.185**	**1.065**	**1.017**	**1.005**	???
2010	4.445	2.078	**1.500**	**1.185**	**1.065**	**1.017**	**1.005**	???
2011	4.611	**2.000**	**1.500**	**1.185**	**1.065**	**1.017**	**1.005**	???
2012	**4.300**	**2.000**	**1.500**	**1.185**	**1.065**	**1.017**	**1.005**	???
Selected	**4.300**	**2.000**	**1.500**	**1.185**	**1.065**	**1.017**	**1.005**	**???**

Paid Loss Development Data
"Squaring the Triangle"

Accident Year	Accident Year Paid Losses (in $000s) Cumulative Totals by Development Age in Months							
	12	24	36	48	60	72	84	96
2005	696	2,785	5,262	8,178	9,522	10,604	10,803	10,852
2006	776	3,907	8,383	12,748	14,161	14,805	15,045	**15,121**
2007	1,058	4,344	8,501	11,912	15,148	15,878	**16,148**	**16,229**
2008	1,106	4,589	7,929	12,618	14,967	**15,940**	**16,211**	**16,292**
2009	1,230	4,829	10,355	15,425	**18,278**	**19,466**	**19,797**	**19,896**
2010	1,281	5,696	11,836	**17,754**	**21,038**	**22,405**	**22,786**	**22,900**
2011	1,217	5,609	**11,218**	**16,827**	**19,940**	**21,236**	**21,597**	**21,705**
2012	1,406	**6,046**	**12,090**	**18,135**	**21,490**	**22,887**	**23,276**	**23,392**

Loss Development Factors
The Tail Factor

- Loss development beyond the oldest age observed in the historical data

- Several approaches
    - Insurance industry benchmarks
    - Curve fitting / extrapolation
    - Other mathematical / statistical models?

Loss Development Factors
Age-Ultimate

Accident Year	Age (Months)	Selected Age-Age LDF	Selected Age-Ultimate LDF
2005	96		**1.010**
2006	84	1.005	1.015 = 1.005 x 1.010
2007	72	1.017	1.032 = 1.017 x 1.015
2008	60	1.065	1.099 = 1.065 x 1.032
2009	48	1.185	1.303 = 1.185 x 1.099
2010	36	1.500	1.954 = 1.500 x 1.303
2011	24	2.000	3.908 = 2.000 x 1.954
2012	12	4.300	16.806 = 4.300 x 3.908

Paid Development Method

(1) Accident Year	(2) Age (Months)	(3) Cumulative Paid Loss as of 12/31/12	(4) Selected Age-Ultimate LDF	(5) = (3) x (4) Projected Ultimate Loss
2005	96	10,852	1.010	10,961
2006	84	15,045	1.015	15,271
2007	72	15,878	1.032	16,386
2008	60	14,967	1.099	16,449
2009	48	15,425	1.303	20,098
2010	36	11,836	1.954	23,128
2011	24	5,609	3.908	21,921
2012	12	1,406	16.806	23,627
Total		**91,019**		**147,841**

Paid Loss Development Method
Implicit Assumptions

- Volume of historical loss data is large enough to be credible

- Future payment patterns will be similar to historically observed patterns
  - Changes to insurers operations
  - Changes to judicial / legal environment
  - New types of claims not seen before

Loss Development Factors

Ultimate Loss = Paid Loss x LDF

$$\text{LDF} = \frac{\text{Ultimate Loss}}{\text{Paid Loss}}$$

$$\frac{1.0}{\text{LDF}} = \frac{\text{Paid Loss}}{\text{Ultimate Loss}} = \% \text{ Paid}$$

Paid Development Method
Sensitivity to Data Fluctuations

(1) Accident Year	(2) Paid at 12 Months	(3) Estimated Ultimate Loss as of 12/31/12	(4) = (2) / (3) Percentage Paid at 12 Months	(5) =(3) / (2) Implied Age-Ult LDF
2005	696	10,961	6.3%	16.384
2006	776	15,271	**5.1%**	**19.679**
2007	1,058	16,386	6.4%	15.517
2008	1,106	16,449	**6.7%**	**14.873**
2009	1,230	20,098	6.1%	16.340
2010	1,281	23,128	5.5%	18.055
2011	1,217	21,921	5.5%	18.012
2012	1,406	23,627	6.0%	16.804

Paid Loss Development Method
Sensitivity to Data Fluctuations

(1) Accident Year	(2) Age (Months)	(3) Cumulative Paid Loss as of 12/31/12	(4) Age-Ultimate LDF	(5) = (3) x (4) Projected Ultimate Loss
2012	12	1,406	**14.873**	20,911
2012	12	1,406	**16.806**	23,629
2012	12	1,406	**19.679**	27,669

Incurred Development Method

- Same basic idea as the Paid Development Method

- Use case incurred losses
  (paid losses + case reserves)
  instead of paid losses

- Takes advantage of the information provided by the claims adjusters

- Incurred losses generally develop more quickly than paid losses

Incurred Loss Data
Loss Development Triangle

Accident Year	Accident Year Case Incurred Losses (in $000s) Cumulative Totals by Development Age in Months							
	12	**24**	**36**	**48**	**60**	**72**	**84**	**96**
2005	3,064	5,480	8,502	9,877	10,646	11,042	10,964	11,014
2006	4,978	9,472	12,569	14,146	14,854	15,426	15,496	
2007	6,777	10,737	13,107	14,818	16,142	16,452		
2008	7,371	10,515	13,287	15,555	16,239			
2009	7,871	12,020	16,354	19,177				
2010	9,152	12,141	16,048					
2011	9,615	12,433						
2012	8,233							

Incurred Loss Data
Loss Development Factor Selection

Accident Year	12-24	24-36	36-48	58-60	60-72	72-84	84-96	96-Ult
2005	1.788	1.551	1.162	1.078	1.037	0.993	1.005	
2006	1.903	1.327	1.125	1.050	1.038	1.005		
2007	1.584	1.221	1.131	1.089	1.019			
2008	1.427	1.264	1.171	1.044				
2009	1.527	1.361	1.173					
2010	1.327	1.322						
2011	1.293							
Wtd Avg	1.491	1.323	1.153	1.064	1.031	1.000	1.005	
Selected	1.475	1.325	1.150	1.065	1.030	1.010	1.005	
Age-Ultimate	**2.512**	**1.703**	**1.285**	**1.117**	**1.049**	**1.018**	**1.008**	**1.003**

Incurred Development Method

(1) Accident Year	(2) Age (Months)	(3) Cumulative Incurred Loss as of 12/31/12	(4) Selected Age-Ultimate LDF	(5) = (3) x (4) Projected Ultimate Loss
2005	96	11,014	1.003	11,047
2006	84	15,496	1.008	15,620
2007	72	16,452	1.018	16,748
2008	60	16,239	1.049	17,035
2009	48	19,177	1.117	21,421
2010	36	16,048	1.285	20,622
2011	24	12,433	1.703	21,173
2012	12	8,233	2.512	20,680
Total		**115,092**		**144,346**

Incurred Development Method
Implicit Assumptions

- Volume of historical loss data is large enough to be credible

- Future reporting patterns will be similar to historically observed patterns
  - No change in case reserving practice / philosophy
  - No changes in data processing procedures
  - No changes in risk exposure
  - No new types of claims not seen before
  - Etc.

Incurred Development Method
Sensitivity to Data Fluctuations

(1) Accident Year	(2) Incurred at 12 Months	(3) Estimated Ultimate Loss as of 12/31/12	(4) = (2) / (3) Percentage Reported at 12 Months	(5) = (3) / (2) Implied Age-Ult LDF
2005	3,064	11,047	27.7%	3.605
2006	4,978	15,620	31.9%	3.138
2007	6,777	16,748	40.5%	2.471
2008	7,371	17,035	43.3%	2.311
2009	7,871	21,421	**36.7%**	**2.722**
2010	9,152	20,622	44.4%	2.253
2011	9,615	21,173	**45.4%**	**2.202**
2012	8,233	20,680	39.8%	2.512

Incurred Development Method
Sensitivity to Data Fluctuations

(1) Accident Year	(2) Age (Months)	(3) Cumulative Incurred Loss as of 12/31/12	(4) Age-Ultimate LDF	(5) = (3) x (4) Projected Ultimate Loss
2012	12	8,233	**2.202**	18,129
2012	12	8,233	**2.512**	20,681
2012	12	8,233	**2.722**	22,410

Comparison of Methods
Expected Loss Ratio vs. Loss Development

- Expected Loss Ratio

  - Exposure based

  - Ignores actual loss experience

  - Stable estimates

- Loss Development

  - Ignores exposure

  - Based on actual loss experience

  - Estimates change in response to new information

Emergence Over Time

Change in Estimates Over Time
Loss Rate Method

		Accident Year 2007 Values at 12/31/XX					
		2007	2008	2009	2010	2011	2012
(1)	Earned Premium	19,550	19,550	19,550	19,550	19,550	19,550
(2)	Expected Loss Ratio	75%	75%	75%	75%	75%	75%
(3)	**Expected Ultimate Loss = (1) x (2)**	**14,663**	**14,663**	**14,663**	**14,663**	**14,663**	**14,663**
(4)	Paid Loss	1,058	4,344	8,501	11,912	15,148	15,878
(5)	**Estimated Loss Reserve = (3) – (2)**	**13,605**	**10,319**	**6,162**	**2,751**	**(485)**	**(1,215)**

Change in Estimates Over Time
Incurred Development Method

		Accident Year 2007 Values at 12/31/XX					
		2007	2008	2009	2010	2011	2012
(1)	Age	12	24	36	48	60	72
(2)	Incurred Loss	6,777	10,737	13,107	14,818	16,142	16,452
(3)	Age-Ult LDF	2.512	1.703	1.285	1.117	1.049	1.018
(4)	**Projected Ultimate Loss = (2) x (3)**	**17,024**	**18,286**	**16,842**	**16,552**	**16,933**	**16,748**
(5)	Paid Loss	1,058	4,344	8,501	11,912	15,148	15,878
(6)	**Estimated Loss Reserve = (4) − (5)**	**15,966**	**13,942**	**8,341**	**4,640**	**1,785**	**870**

Bornhuetter-Ferguson Method

		2007	2008	2009	2010	2011	2012
		... Accident Year 2007 Values at 12/31/XX					
(1)	Earned Premium	19,550	19,550	19,550	19,550	19,550	19,550
(2)	Expected Loss Ratio	75%	75%	75%	75%	75%	75%
(3)	Expected Ultimate Loss = (1) x (2)	14,663	14,663	14,663	14,663	14,663	14,663
(4)	Age-Ult LDF	2.512	1.703	1.285	1.117	1.049	1.018
(5)	Expected Percentage Unreported = 1 − 1/(4)	60.2%	41.3%	22.2%	10.5%	4.7%	1.8%
(6)	Expected Unreported Loss = (3) x (5)	8,827	6,056	3,255	1,540	689	264
(7)	**Projected Ultimate Loss**	**15,604**	**16,793**	**16,362**	**16,358**	**16,831**	**16,716**
(8)	Paid Loss	1,058	4,344	8,501	11,912	15,148	15,878
(9)	**Estimated Loss Reserve = (7) − (8)**	**14,546**	**12,449**	**7,861**	**4,446**	**1,683**	**838**

Bornhuetter-Ferguson Method

(1) Accident Year	(2) Earned Premium	(3) Expected Loss Ratio	(4)=(2)x(3) Expected Ultimate Loss	(5) Incurred LDF	(6)=1.0–1.0/(5) Expected Percent Unreported	(7)=(4)x(5) Estimated IBNR Reserve	(8) Actual Incurred Loss	(9)=(7)+(8) Estimated Ultimate Loss
2005	14,784	75%	11,088	1.003	0.3%	33	11,014	11,048
2006	17,468	75%	13,101	1.008	0.8%	105	15,496	15,601
2007	19,550	75%	14,663	1.018	1.8%	264	16,452	16,716
2008	21,243	75%	15,932	1.049	4.7%	749	16,239	16,988
2009	24,003	75%	18,002	1.117	10.5%	1,890	19,177	21,067
2010	24,866	75%	18,649	1.285	22.2%	4,140	16,048	20,189
2011	25,843	75%	19,382	1.703	41.3%	8,005	12,433	20,437
2012	27,487	75%	20,615	2.512	60.2%	12,410	8,233	20,643
Total	**175,243**		**131,432**			**27,596**	**115,092**	**142,688**

Bornhuetter-Ferguson Method
Implicit Assumptions

- Premium is an accurate measure of exposure

- Expected loss ratio is predictable

- Constant reporting, case reserving and settling

Final Selection

(1) Accident Year	(2) Paid Loss Development	(3) Incurred Loss Development	(4) Incurred Bornhuetter-Ferguson	(5) Expected Loss Rate	(6) Selected Ultimate Loss as of 12/31/12	(7) Paid Loss as of 12/31/12	(8) = (6) − (7) Estimated Loss Reserve as of 12/31/12
2005	10,961	**11,047**	11,048	11,088	11,047	10,852	195
2006	15,271	**15,620**	15,601	13,101	15,620	15,045	575
2007	16,386	**16,748**	16,716	14,663	16,748	15,878	870
2008	16,449	**17,035**	16,988	15,932	17,035	14,967	2,068
2009	20,098	**21,421**	21,067	18,002	21,421	15,425	5,996
2010	23,128	**20,622**	20,189	18,649	20,622	11,836	8,786
2011	21,921	21,173	**20,437**	19,382	20,437	5,609	14,828
2012	23,627	20,680	**20,643**	20,615	20,643	1,406	19,237
Total	147,841	144,346	142,688	131,432	143,573	91,019	52,554

Data Considerations & Communication

Data Considerations
Homogeneity

- Different types of claims develop differently
- Subdividing the data can improve accuracy

Automobile

Liability

Bodily Injury

Property Damage

PIP   Med Pay

UM-BI   UM-PD

Physical Damage

Collision

Other Than Collision

Data Considerations
Credibility

- Is there enough data for it to have predictive value?

  – Homogeneity vs. Credibility

  – Small program (e.g. self-insurer or captive)

  – Type of coverage

    • Low frequency / high severity

    • Long reporting lags

    • Long tail

- Use supplementary data sources (industry data, countrywide data, etc.)

Communicating the Results
Basis of Presentation

- What do we think our answer means?
  - Mean, median, mode?
  - Percentile?
  - "Actuarial Central Estimate"

- Are the estimates discounted for the time value of money?

- Have they been adjusted for future recoveries? Salvage and subrogation? Reinsurance

- Etc.

Communicating the Results
Intended Purpose

- Know the audience
  - Company management
  - Potential investors
  - Insurance regulators
  - Others?

Advanced Topic

Advanced Topic
Stochastic Reserving

- Actual outcome is inherently uncertain

- Can we understand the potential variability?

- Business value
  - Risk Management
  - Fair value of liabilities

- External Pressures
  - Solvency II in Europe
  - Own Risk and Solvency Assessment in U.S.
  - International Financial Reporting Standards

Casualty Actuarial Society
4350 North Fairfax Drive, Suite 250
Arlington, Virginia 22203

www.casact.org