

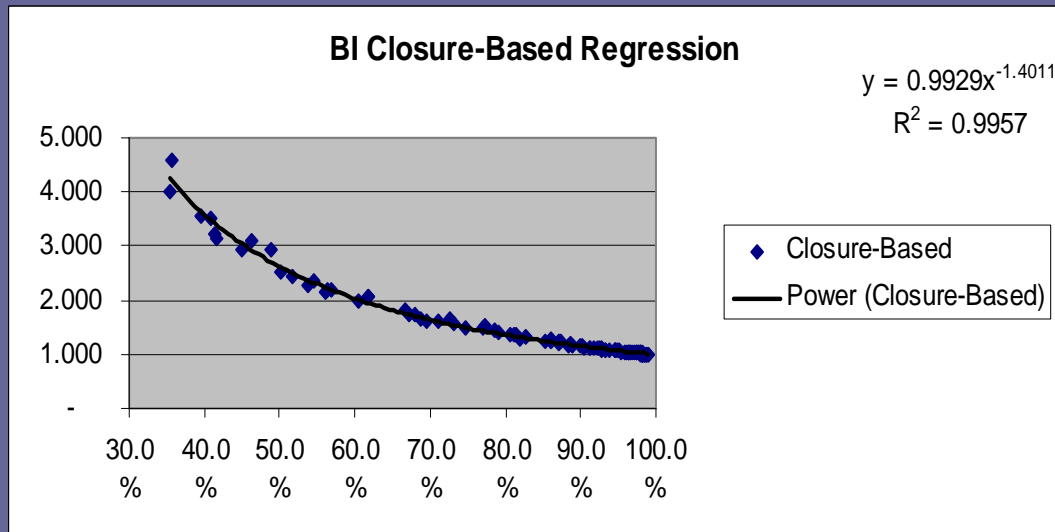
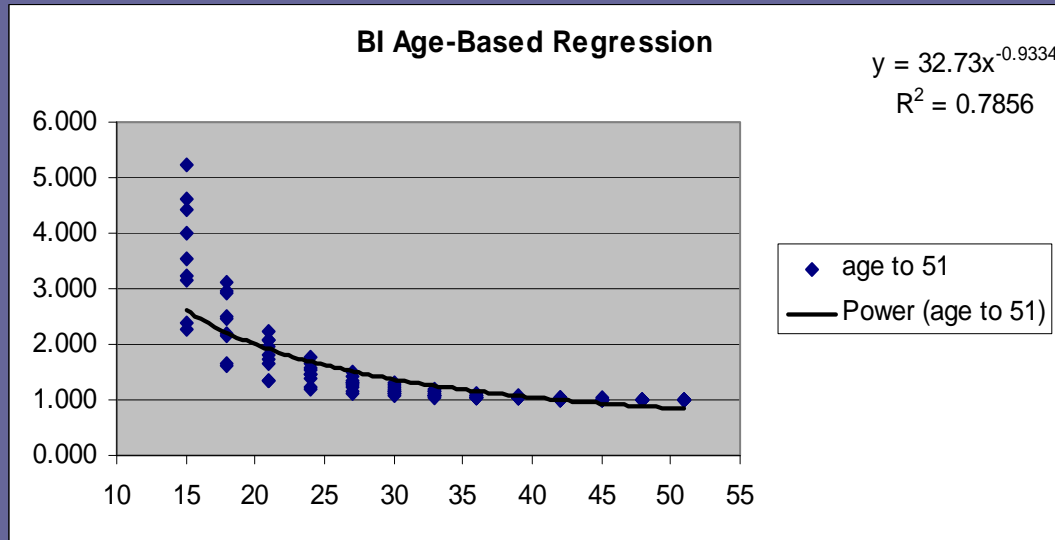
Closure-Based Regression Method

Steve Marsden, FCAS, MAAA

Closure-Based Regression Method

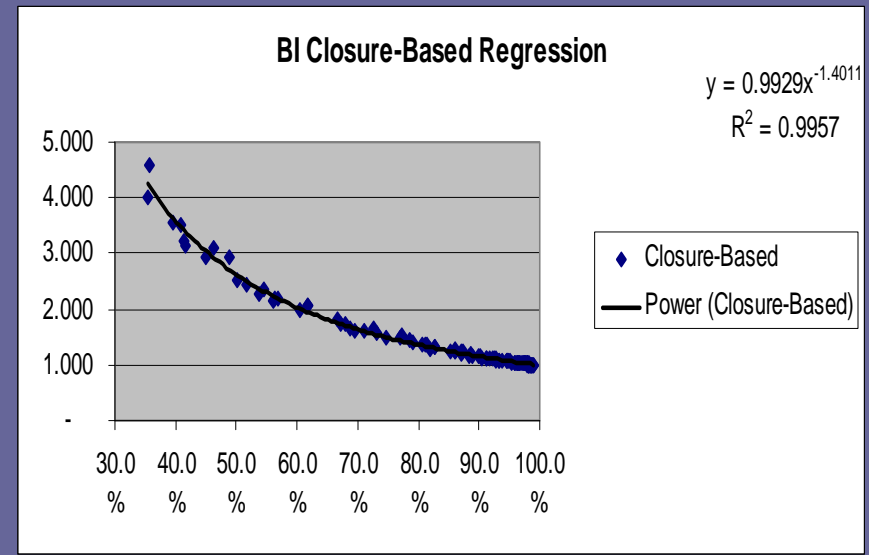
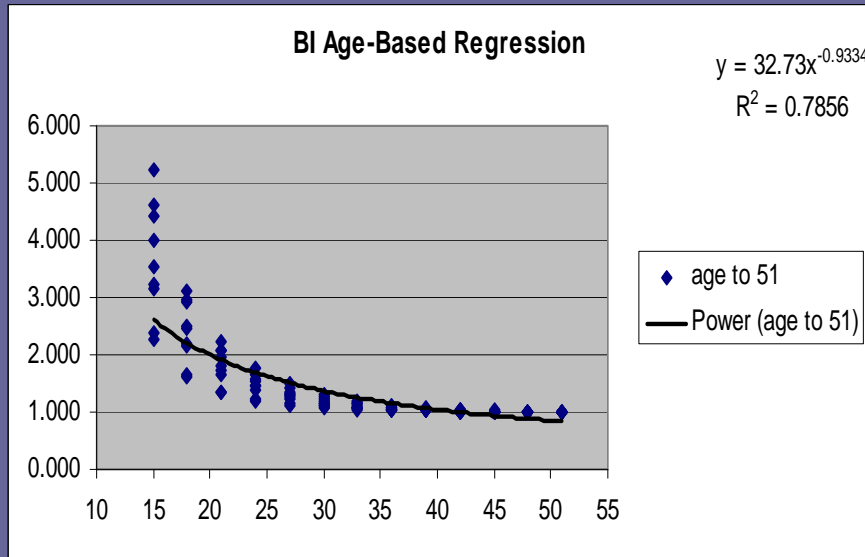
Should Paid Loss Development Be Based on Age or Closure ?

Closure-Based Regression Method



Same data grouped by age (top slide) and closure (bottom slide) from a large book of personal lines nonstandard auto business (high frequency and low severity)

Closure-Based Regression Method



- **Amazingly tight fit for Bodily Injury using only simple regression !!!**
- Visual evidence is compelling and provides confidence
- Age is definitely less predictive than closure
- Multiple regression may only add incremental benefit for added complexity
- The variance shown at young ages is not trend but represents only differences in closure
- A very accurate loss development pattern can be established at a 35% closure ratio

Closure-Based Regression Method

Similar To The Berquist Sherman Method

- Replaces an age-based concept with a closure-based concept
- Adds most value when settlement rates change in time
- Leverages the fact that age is a poor surrogate for closure rate
- Traditional methods may incorrectly develop losses
 - Sudden increase in settlement rate likely will lead to over-projection
 - Sudden decrease in settlement rate likely will lead to under-projection

Closure-Based Regression Method

Berquist Sherman Method

- Traditional triangle-based chain ladder approach
- Counts and interpolation to replace an age-based triangle with a closure-based triangle

Closure-Based Regression Method

- Uses a direct simple regression of the relationship between closure ratio and LDF
- Provides visual evidence of the relationship to LDF

Closure-Based Regression Method

Advantages Over Berquist Sherman

- Provides visual evidence of the relationship of age or closure to LDF
- Directly Measures Relationship and Does Not Add Error Thru
 - Chain Ladder Approach
 - Interpolation In Reconstructing Triangle

Disadvantage To Berquist Sherman

- Berquist Sherman Utilizes More Recent Data

Closure-Based Regression Method

Questions Before Mechanics of Methodology?

(Can Reference Paper Later For Mechanics)

Closure-Based Regression Method

Mechanics: Brief Overview

- Exhibit Numbers Differ From Paper (*Follow Slides Not Paper*)
- Retrospective Review of 2 Data Elements
 - Closure Ratio $CWA / (CWA + Open)$
 - Paid LDF at that Closure Ratio to 99% Closed (*Tail Later*)
- Collect These at Multiple Data Points and Regress
- Triangle is Not Required

Closure-Based Regression Method

Exhibit 4

Net Paid Loss & ALAE Closure Point to 99% Closed LDF

	<u>3</u>	<u>6</u>	<u>9</u>	<u>12</u>	<u>15</u>	<u>18</u>
1993	792.311	42.947	10.791	4.591	2.360	1.597
1994	201.656	21.266	7.951	3.539	2.259	1.638
1995	328.975	25.113	8.079	4.629	3.149	2.510
1996	2,147.759	112.936	23.453	7.853	4.006	2.444
1997	709.663	61.321	14.756	5.942	3.239	2.190
1998	525.323	70.560	23.064	8.687	4.592	2.925
1999	939.910	77.655	17.288	7.633	4.369	2.943
2000	855.700	83.529	22.669	9.696	5.188	3.083
2001	685.764	82.899	18.259	6.762	3.500	2.146

Closure-Based Regression Method

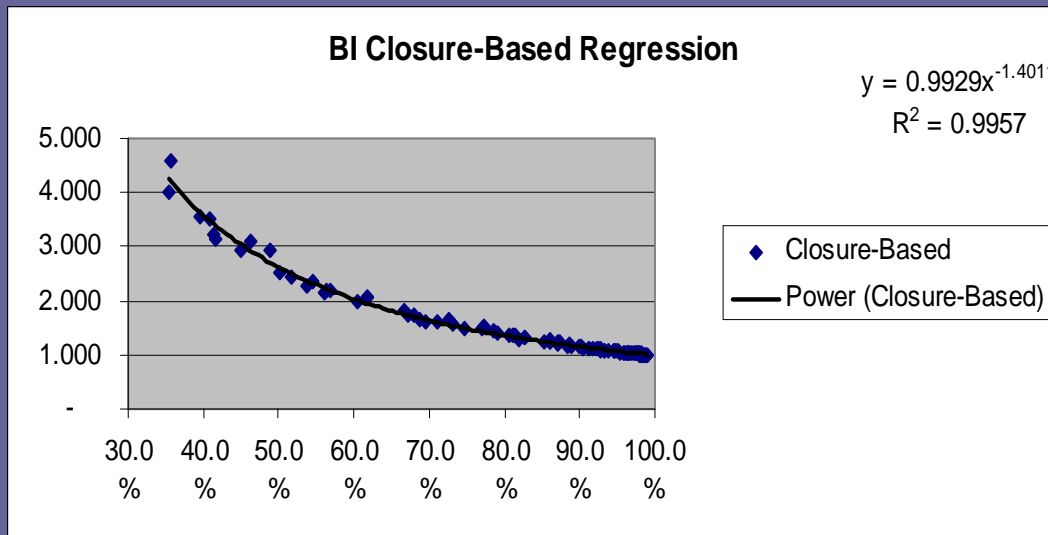
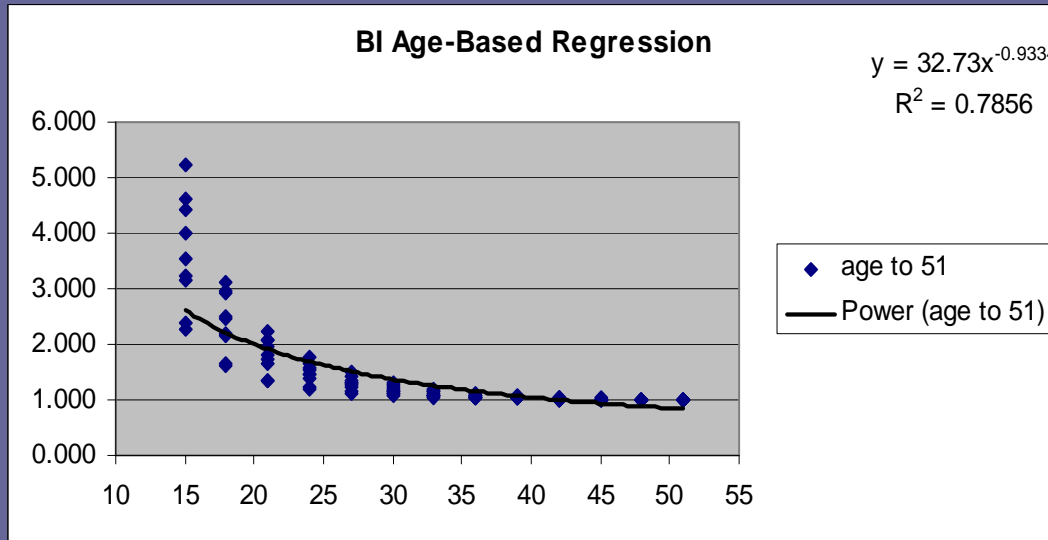
Exhibit 5

% Closed at Point

LDF from Point to 99% Closed

4.01%	792.311
9.25%	201.656
7.45%	328.975
3.47%	2,147.759
5.99%	709.663
6.74%	525.323
4.47%	939.910
5.91%	855.700
5.17%	685.764
12.87%	42.947
19.78%	21.266
16.27%	25.113
7.30%	112.936
9.87%	61.321
13.53%	70.560

Closure-Based Regression Method



▪ Relative Strength of Fits

▪ One Curve or Splines ?

Closure-Based Regression Method

In this case we have fit two curves to the data

- The first curve fits to 80% closed
- The second curve fits from 80% closed to 99% closed

Closure-Based Regression Method

Exhibit 7

Estimated Net Paid Loss & ALAE

Year	Ratio 1	Ratio 2	Value 1	Value 2	Ratio 3	Value 3	Value 4	Ratio 4	Ratio 5	Ratio 6	Value 5
1993	71.19%	82.61%	11,831,534	14,278,225	80.00%	0.088	0.114	77.2%	22.8%	<u>80%</u>	13,719,250
1994	68.76%	81.04%	11,220,809	13,671,712	80.00%	0.112	0.123	91.6%	8.4%		13,464,777
1995	73.06%	81.30%	10,599,555	12,270,046	80.00%	0.069	0.082	84.2%	15.8%		12,006,002
1996	78.45%	86.11%	13,009,514	15,069,204	80.00%	0.016	0.077	20.3%	79.7%		13,427,078
1997	77.10%	82.63%	21,862,315	24,265,740	80.00%	0.029	0.055	52.4%	47.6%		23,121,585
1998	79.11%	85.29%	26,921,907	30,469,043	80.00%	0.009	0.062	14.4%	85.6%		27,434,387
1999	74.56%	81.91%	32,175,666	37,193,603	80.00%	0.054	0.073	74.1%	25.9%		35,891,725
2000	77.22%	86.10%	28,087,482	33,234,257	80.00%	0.028	0.089	31.3%	68.7%		29,698,193
2001	69.56%	80.55%	21,805,864	26,100,833	80.00%	0.104	0.110	95.0%	5.0%		25,886,454
2002	74.93%	82.28%	25,809,388	29,432,258	80.00%	0.051	0.074	69.0%	31.0%		28,309,584
2003	79.95%	85.24%	23,335,756	25,477,508	80.00%	0.000	0.053	0.9%	99.1%		23,354,111

Closure-Based Regression Method

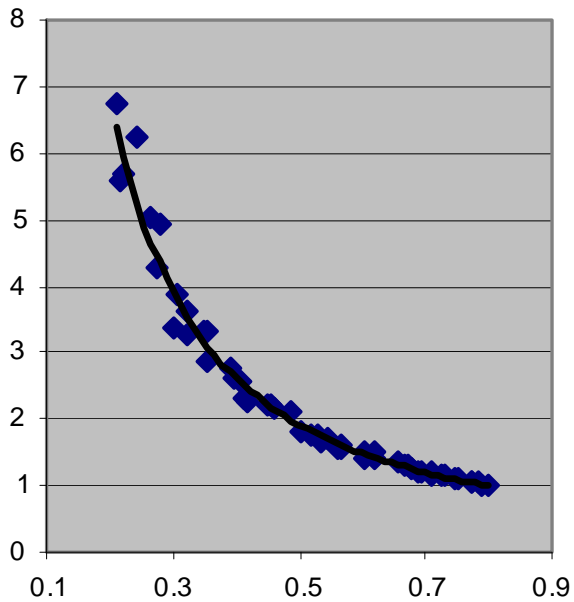
% Closed to 80% Closed Regression		80% Closed to 99% Closed Regression	
<u>closure ratio</u>	<u>LDF</u>	<u>closure ratio</u>	<u>LDF</u>
21.14%	6.758	80.5%	1.360
21.88%	5.605	81.0%	1.345
21.95%	5.683	81.3%	1.349
24.50%	6.242	81.9%	1.296
26.46%	5.027	82.6%	1.323
27.70%	4.282	82.6%	1.322
27.77%	4.931	85.3%	1.253
30.13%	3.358	86.1%	1.226
30.79%	3.880	86.1%	1.282
32.33%	3.616	86.1%	1.248
32.50%	3.253	87.1%	1.222
34.78%	3.333	87.1%	1.209
35.33%	2.859	87.3%	1.222
35.65%	3.299	88.3%	1.165
39.10%	2.752	88.7%	1.184
39.54%	2.592	89.0%	1.157
40.94%	2.553	90.0%	1.170

Closure-Based Regression Method

Exhibit 10

BI Closure % to 80% Closed

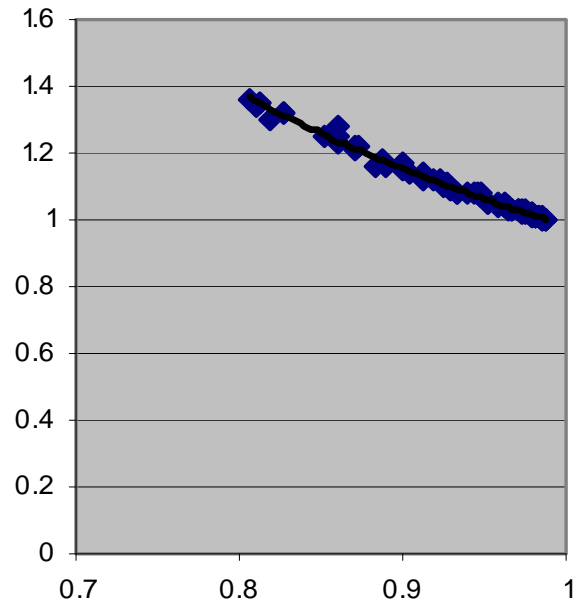
$$y = 0.7271x^{-1.3997}$$
$$R^2 = 0.9906$$



◆ 80%
— Power (80%)

BI 80% Closed to 99% Closed

$$y = 0.9825x^{-1.5244}$$
$$R^2 = 0.9907$$



◆ 99%
— Power (99%)

Closure-Based Regression Method

Exhibit 11

Accident	Closure	Point To	LDF To			Cumulative Net Paid	Ultimate Net Paid
<u>Year</u>	<u>Ratio</u>	<u>80% Closed</u>	<u>99% Closed</u>	<u>Tail</u>	<u>LDF</u>	<u>Loss & ALAE</u>	<u>Loss & ALAE</u>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1993	100.00%	1.000	1.000	1.000	1.000	19,099,702	19,099,702
1994	100.00%	1.000	1.000	1.000	1.000	18,516,810	18,516,810
1995	100.00%	1.000	1.000	1.000	1.000	16,799,150	16,799,150
1996	100.00%	1.000	1.000	1.000	1.000	19,119,479	19,119,709
1997	100.00%	1.000	1.000	1.000	1.000	32,428,319	32,428,694
1998	99.98%	1.000	1.000	1.000	1.000	38,704,779	38,715,487
1999	99.95%	1.000	1.000	1.000	1.000	49,192,079	49,212,336
2000	99.86%	1.000	1.000	1.002	1.002	43,227,069	43,325,885
2001	99.56%	1.000	1.000	1.007	1.007	35,783,290	36,031,280
2002	96.75%	1.000	1.033	1.016	1.050	37,396,259	39,260,406
2003	89.45%	1.000	1.165	1.016	1.183	27,340,774	32,350,451
2004	56.69%	1.609	1.381	1.016	2.257	13,256,219	29,920,994
2005	14.80%	N/A	N/A	N/A	N/A	N/A	N/A

Closure-Based Regression Method

Exhibit 11
Worksheet

$$.7271x(.5669)^{-1.3997}=1.609$$

$$.9825x(.8945)^{-1.5244}=1.165$$

$$.9825x(.8000)^{-1.5244}=1.381$$

Closure-Based Regression Method



Questions ?