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A GLM-BASED APPROACH TO ADJUSTING FOR CHANGES IN CASE RESERVE ADEQUACY

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2012 CAS Loss Reserve Seminar

Session CP-3, Thursday, September 6, 2012

Overview of Presentation

- Discuss how simulated data was created
- Review of Berquist-Sherman method
- Go over example from the paper

Simulated Data

- Data was created using the CAS Public Loss Simulator Model
- Can set parameters for levels of case reserve adequacy
- Created two sets of transaction level detail for accident years 2000-2009 – one with low case reserve adequacy and one with high case reserve adequacy
  - Note that payment patterns and ultimate losses are the same for both data sets
- Data for the example was created by combining the two sets
  - From the **low** adequacy set, transactions with dates in calendar years **2000 – 2008** were used
  - From the **high** adequacy set, transactions with dates in calendar year **2009** were used

Simulated Data (cont.)

- Simulated claims varied by Injury, Gender, and Claimant Age at time of accident (40 combinations) .
- Severity Parameters for Accident Year 2000:

		Severity
Injury	Burn	100
	Spinal Cord	500
	Back	200
	Other	50

		Severity Relativity
Gender	M	0.80
	F	1.20

		Severity Relativity
Age	Under 16	0.50
	16-25	0.75
	26-45	1.00
	46-65	1.50
	66 and Over	2.00

Simulated Data (cont.)

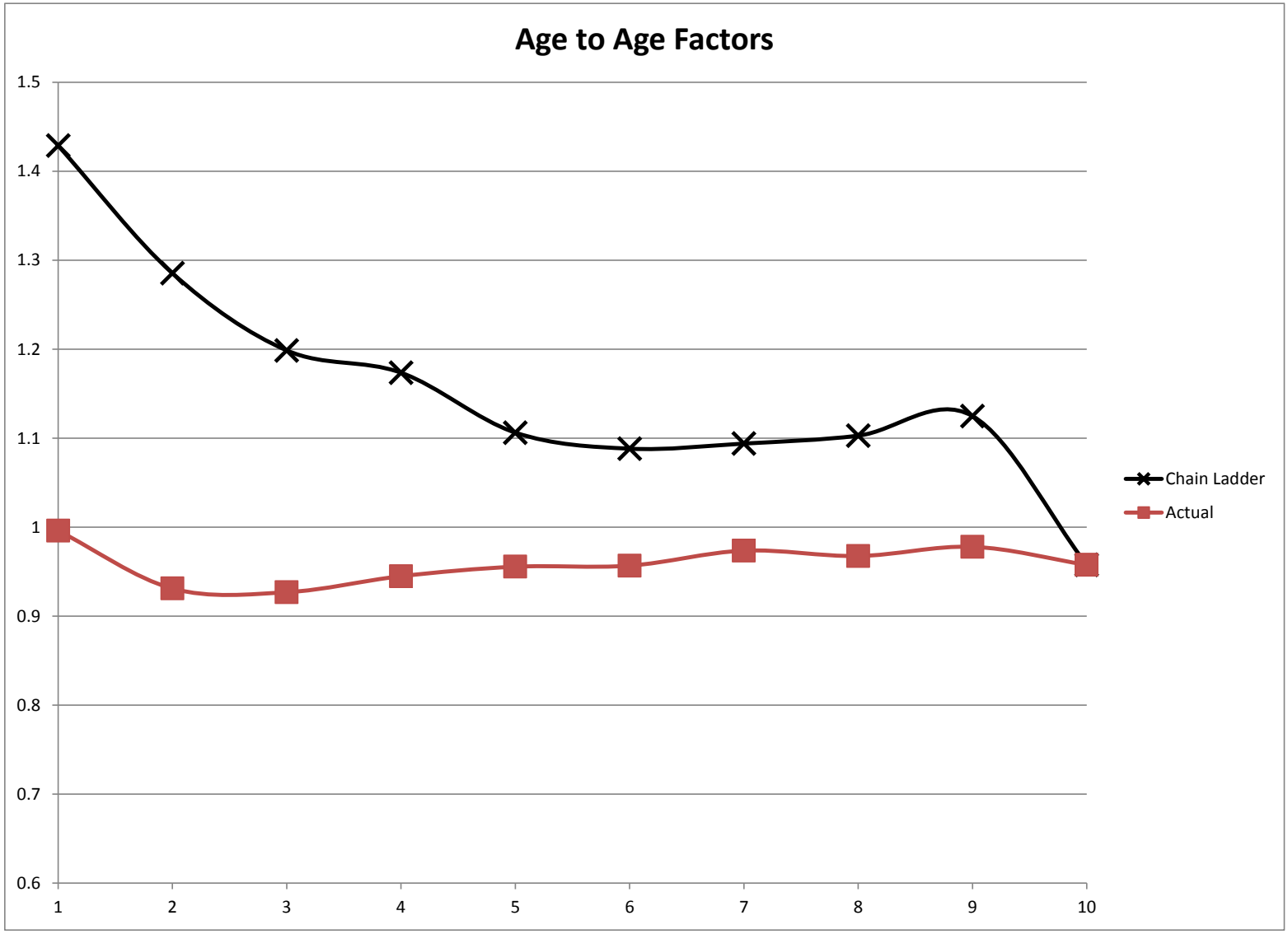
- 5% inflation trend was applied to subsequent years.
- Gamma distributions were used for severity.
- For accident year 2000, mean claim counts were randomly assigned to each of the 40 claim types with an expected total number of claims of 600.
- The total number of claims for subsequent accident years were increased by 10% per year, with a new random assignment to the 40 claim types.

Simulated Data (cont.)

Average Reserves

Accident Year	Age 1	2	3	4	5	6	7	8	9	10
2000	107	111	108	109	111	119	112	126	126	292
2001	169	167	178	191	205	219	219	256	554	
2002	144	150	161	170	155	159	167	379		
2003	147	154	164	182	182	203	399			
2004	126	134	144	122	129	278				
2005	157	164	179	171	400					
2006	156	157	158	372						
2007	169	179	452							
2008	218	537								
2009	598									

Chain Ladder



Berquist-Sherman Example

Restated Avg. Reserve (Latest Average Reserve Detrended)

Accident Year	Age 1	2	3	4	5	6	7	8	9	10
2000	386	364	322	277	313	229	345	344	528	292
2001	405	382	338	291	329	241	362	361	554	
2002	425	401	355	306	345	253	380	379		
2003	447	421	372	321	363	265	399			
2004	469	442	391	337	381	278				
2005	492	464	410	354	400					
2006	517	487	431	372						
2007	543	512	452							
2008	570	537								
2009	598									

Open Claim Count

Accident Year	Age 1	2	3	4	5	6	7	8	9	10
2000	606	569	479	385	310	245	191	148	123	88
2001	656	620	511	416	330	265	209	154	108	
2002	724	706	601	464	350	274	223	172		
2003	753	700	580	466	365	274	211			
2004	740	712	614	494	404	315				
2005	939	895	740	603	462					
2006	939	885	743	607						
2007	1,169	1,116	935							
2008	1,221	1,158								
2009	1,318									

Paid Losses

Accident Year	Age 1	2	3	4	5	6	7	8	9	10
2000	11,859	24,975	44,312	60,972	73,490	82,477	94,199	98,595	101,078	105,467
2001	13,916	46,989	71,368	86,520	103,005	120,614	134,482	146,104	157,391	
2002	10,726	26,710	47,271	78,252	118,524	135,367	146,345	156,631		
2003	6,386	20,919	46,540	61,770	92,823	111,674	128,699			
2004	14,668	23,949	37,889	85,848	100,959	120,804				
2005	6,117	26,869	58,434	110,236	145,030					
2006	22,453	59,637	95,094							
2007	19,338	60,820	112,036							
2008	28,672	90,411								
2009	54,424									

Restated Incurred

Age

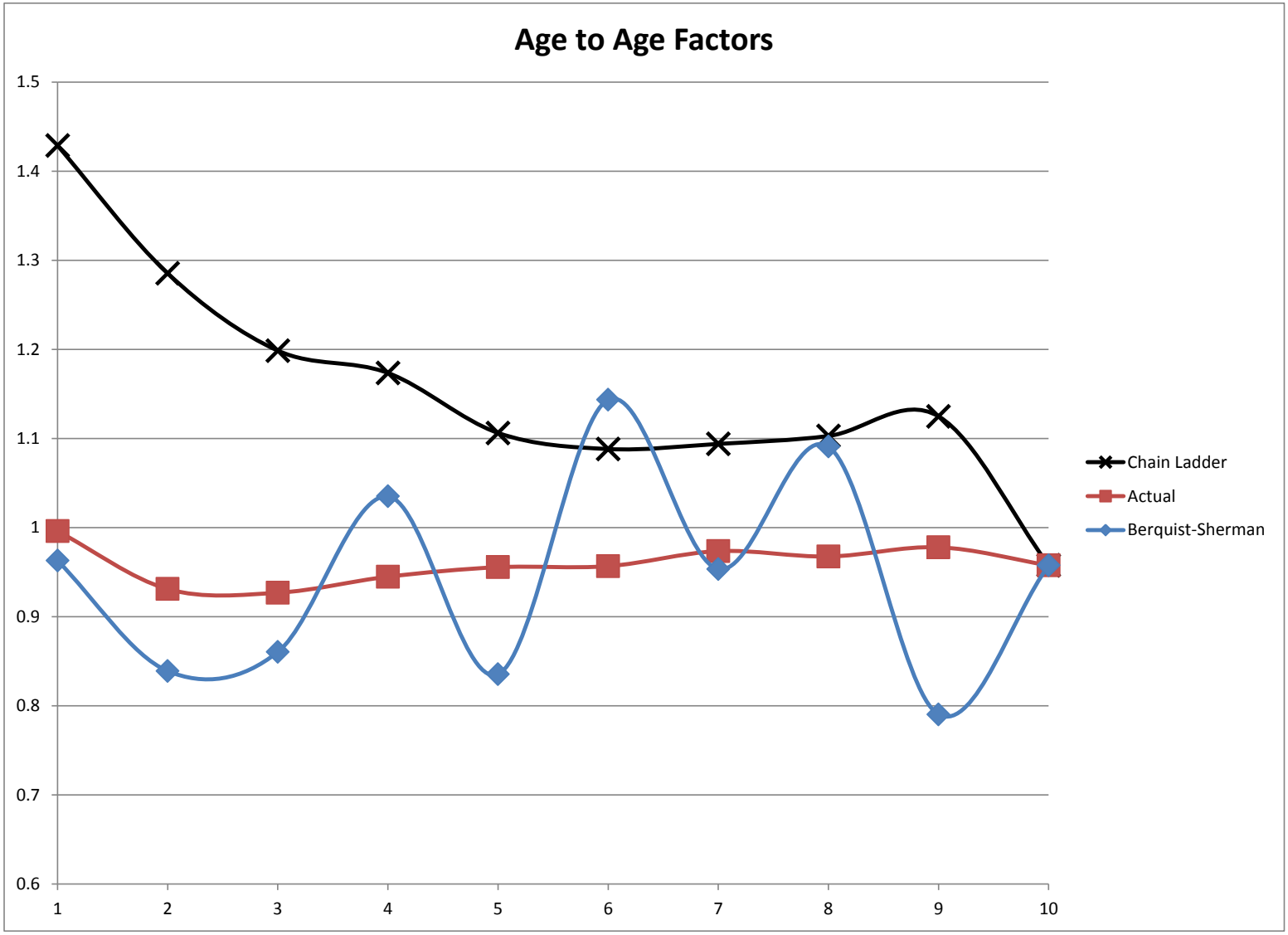
Accident Year	1	2	3	4	5	6	7	8	9	10
2000	245,637	231,956	198,339	167,736	170,619	138,598	159,999	149,517	165,979	131,181
2001	279,635	283,798	243,900	207,649	211,571	184,352	210,083	201,739	217,227	
2002	318,653	309,850	260,337	220,112	239,427	204,565	231,044	221,876		
2003	342,660	315,689	262,442	211,365	225,211	184,331	212,847			
2004	361,660	338,763	277,875	252,361	254,820	208,510				
2005	468,437	442,384	362,129	323,653	329,777					
2006	507,889	491,053	415,267	225,574						
2007	653,894	632,044	535,091							
2008	724,593	712,769								
2009	843,192									

Report to Report Factors

Age

Accident Year	1	2	3	4	5	6	7	8	9	
2000	0.944	0.855	0.846	1.017	0.812	1.154	0.934	1.110	0.790	
2001	1.015	0.859	0.851	1.019	0.871	1.140	0.960	1.077		
2002	0.972	0.840	0.845	1.088	0.854	1.129	0.960			
2003	0.921	0.831	0.805	1.066	0.818	1.155				
2004	0.937	0.820	0.908	1.010	0.818					
2005	0.944	0.819	0.894	1.019						
2006	0.967	0.846	0.543							
2007	0.967	0.847								
2008	0.984									
Wtd Avg	0.963	0.839	0.860	1.035	0.835	1.143	0.953	1.091	0.790	**0.958**
Cumulative	0.541	0.562	0.670	0.778	0.752	0.900	0.787	0.826	0.757	**0.958**

Berquist-Sherman Example



Strengths of Berquist-Sherman

- Gets you closer than unadjusted Chain Ladder
- Relatively easy to calculate and apply
- Easy to understand and explain

Challenges With Berquist-Sherman

- Use of latest average case reserves in column to restate prior periods creates a couple of challenges:
  - “Wavy” loss development pattern due to different mix of claims characteristics by accident year. This makes selecting age to age factors more difficult.
  - Volatility towards the right side of the triangle as fewer open claims are used to base average upon.
- Need to select trend.

GLM Method Step 1

Create a GLM model based on all open claims as of latest evaluation.

- The purpose of the model is to represent your current reserving practice.

GLM Method Step 2

Apply the resulting model to historical open claims to restate their case reserves.

- Each individual open claim is restated in the historical periods to be what it would be under the current reserving practice as represented by the model.
- Note that the modeled historical reserve should be based on its characteristics as of that evaluation.

GLM Method Step 3

Aggregate restated case reserves and add to paid losses to get restated incurred losses.

- Note that de-trending was not necessary in this example since trend captured in model through Accident Year variable.

Open Claim Data as of Latest Evaluation (12/31/2009)

Long Claim	Eval	Reserve	Accident Year	Age	Gender	Clmt Age	Injury
20080100090401	12/31/2009	83	2008	2	M	66 and Over	Back
20050100073101	12/31/2009	13	2005	5	F	26-45	Back
20050100049101	12/31/2009	5533	2005	5	F	46-65	Back
20070100038701	12/31/2009	60	2007	3	F	26-45	Spinal Cord
20070100116801	12/31/2009	124	2007	3	F	26-45	Spinal Cord
20090100087601	12/31/2009	456	2009	1	F	66 and Over	Burn

Some Benefits of R

- It is FREE!
- Collaborative worldwide user community
- Becoming the lingua franca of many statisticians
- Ease of use

R Resources

R can be downloaded from here:
http://www.r-project.org/

CAS Open-Source Software Committee Wiki:
http://opensourcesoftware.casact.org/

Introduction to R LAS, December 3-4, 2012

R Code to Read Data, Create Model, and Predict Historical Reserves

```
# load the package with the Tweedie distribution. This may have to be installed.
library(statmod)

#Read in the 2009 open claims data (latest evaluation)
Open2009<-read.csv("c:/callpaper/2009 Open Claims.csv",sep=",")

#Change the base level for Injury and Clmt.Age
Open2009$Injury<-relevel(Open2009$Injury,"Other")
Open2009$Clmt.Age<-relevel(Open2009$Clmt.Age,"26-45")

#Create the GLM
OpenGLM<-glm(Reserve~Accident.Year+Gender+Clmt.Age+Injury, data=Open2009,
family=tweedie(var.power=2,link.power=0))

#Show the results of the GLM
summary(OpenGLM)

#Read in the data for all of the open claims at all evaluations
OpenAll<-read.csv("c:/callpaper/All Open Claims.csv",sep=",")

#Obtain the restated values for all of the open claims at all evaluations
OpenRestated<-predict(OpenGLM,newdata=OpenAll,type='response')

#set the number of digits to be written out
options("digits"=10)

#Write the restated values to a file
write(OpenRestated,"c:/callpaper/Restated Claims.csv",sep=",",ncolumns=1)
```

Open Claim Data for All Evaluations (2000 -2009) With Restated Reserves

Long Claim	Eval	Reserve	Status	Accident Year	Age	Gender	Clmt Age	Injury	Restated Reserve
20000100000101	12/31/2000	0	Open	2000	1	M	Under 16	Spinal Cord	305.30
20000100000201	12/31/2000	3	Open	2000	1	M	Under 16	Back	133.87
20000100000301	12/31/2000	2	Open	2000	1	M	Under 16	Back	133.87
20000100000401	12/31/2000	0	Open	2000	1	M	Under 16	Back	133.87
20000100000501	12/31/2000	13	Open	2000	1	M	Under 16	Other	31.30
20000100000601	12/31/2000	18	Open	2000	1	M	Under 16	Other	31.30
20000100000701	12/31/2000	5	Open	2000	1	F	Under 16	Burn	90.11

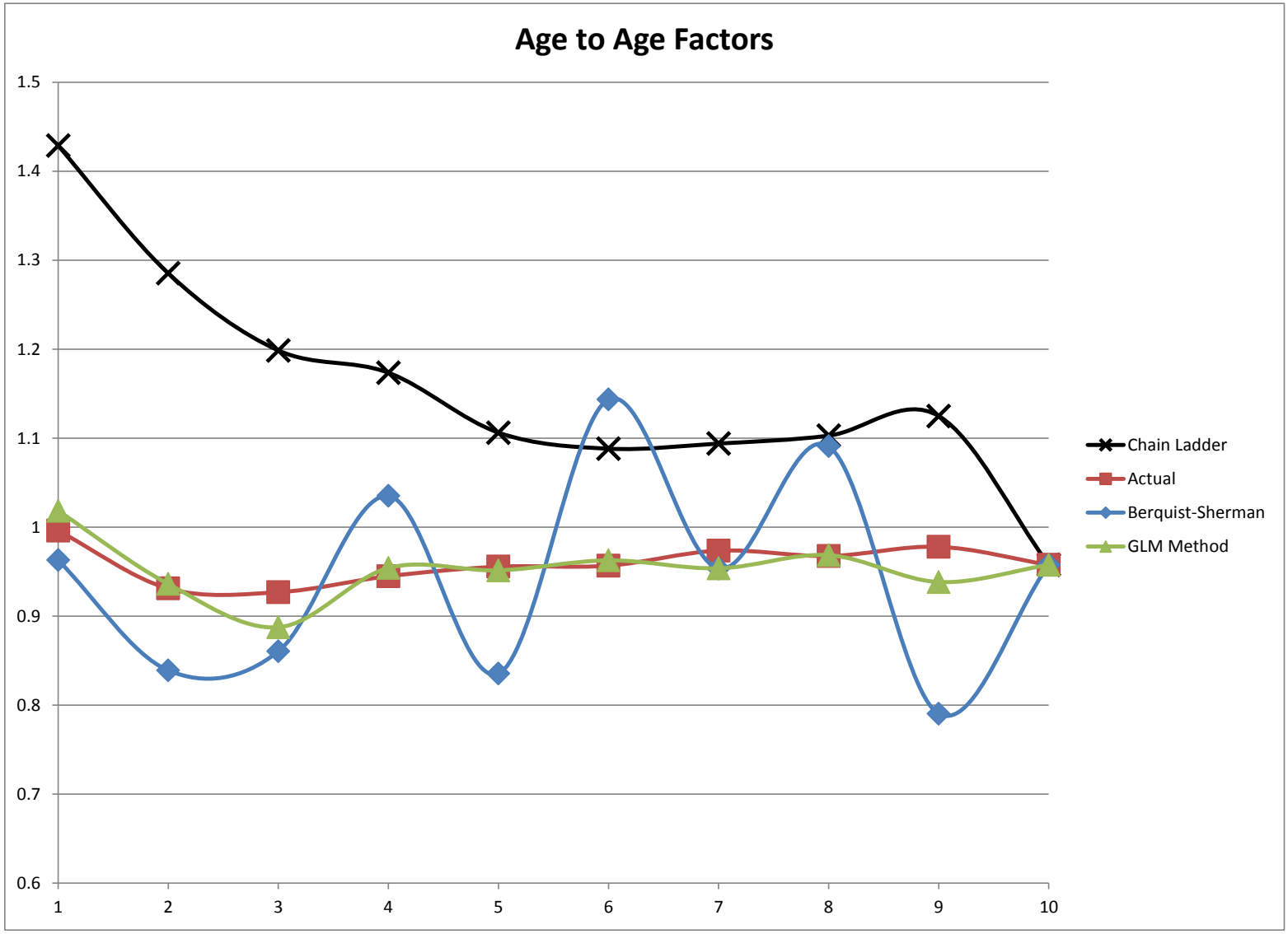
Restated Incurred

Accident Year	Age 1	2	3	4	5	6	7	8	9	10
2000	215,986	221,595	208,286	192,195	179,390	165,559	161,451	150,344	145,092	136,148
2001	299,612	313,156	289,512	268,147	248,964	239,877	226,060	215,527	209,268	
2002	267,800	277,641	259,639	246,478	241,717	230,948	220,188	213,698		
2003	275,795	271,605	250,614	224,541	219,731	208,006	205,183			
2004	296,769	290,533	262,917	263,976	246,487	236,715				
2005	360,195	360,502	335,030	332,421	321,434					
2006	403,626	417,510	402,542	254,882						
2007	528,234	551,033	522,491							
2008	737,099	743,822								
2009	819,351									

Report to Report Factors

Accident Year	Age 1	2	3	4	5	6	7	8	9	
2000	1.026	0.940	0.923	0.933	0.923	0.975	0.931	0.965	0.938	
2001	1.045	0.924	0.926	0.928	0.964	0.942	0.953	0.971		
2002	1.037	0.935	0.949	0.981	0.955	0.953	0.971			
2003	0.985	0.923	0.896	0.979	0.947	0.986				
2004	0.979	0.905	1.004	0.934	0.960					
2005	1.001	0.929	0.992	0.967						
2006	1.034	0.964	0.633							
2007	1.043	0.948								
2008	1.009									
Wtd Avg	1.018	0.936	0.888	0.954	0.951	0.963	0.954	0.969	0.938	**0.958**
Cumulative	0.614	0.603	0.644	0.725	0.760	0.799	0.830	0.870	0.899	**0.958**

GLM Model Age to Age Factors



Benefits of GLM Method

- Elimination of “Wavy” Effect
- More Information Used to Restate Historical Reserves
- Possibly Eliminate Need for Trend Selection
- Side Benefits

Challenges With GLM Method

- More detailed data required
  - May not be available for all historical periods
  - More susceptible to data quality problems
- More difficult to explain to management and outside parties
- Requires more time
- Requires modeling skill set

Ideas for Further Consideration

- Other Models Beside GLM
- Determining Need for Trend Selection

Questions?

Paper and files for reproducing the example can be found at:

http://www.casact.org/pubs/forum/12sumforum/

Feel free to send questions to ldecker@mwecc.com