

Testing Assumptions Underlying Estimates of Loss Reserves

CAS Loss Reserve Seminar

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Objectives

- Introduce the class and its mission
- Discuss resources for the class
 - Facilitators Guide
 - Spreadsheet examples
 - Venter paper on Testing Assumptions
- Hands on walk through one of spreadsheets and tools for the class

Data sets we will use

- AL Min Count
- AL Min Lim
- AI Schedule P Paid with commentary
- These are triangle data sets
- These file available on CAS web site

www.data-mines.com

Why Learn About Regression Models?

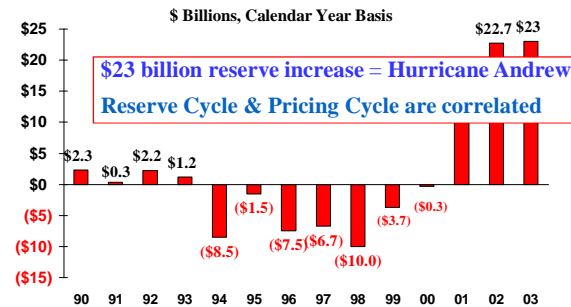
- Competitiveness of our profession
- A key modeling tool familiar to many professionals



S&P Report 19-Nov-2003 *Insurance Actuaries – A Crisis of Credibility*

- S&P report: “Actuaries are signing off on reserves that turn out to be wildly inaccurate ...”
 - It sent a shockwave around the globe in the actuarial and insurance community!!
- American Academy of Actuaries countered 2 days after S&P release: “It is an obvious attempt to explain away the errors that some analysts have made in estimating property/casualty insurers’ earnings.”
- Both agree *It is high-time for Reserving Reformation*”

P/C Insurance Industry Prior Year Reserve Development*



*Year 2003 number is an estimate by S&P.
Source: A.M. Best, Morgan Stanley, Dowling & Partners Securities

From AM Bests Analysis, CAMAR 2014 U.S. Property/Casualty – Estimated Reserve Deficiency

Product Line	12/31/12	12/31/13
Workers' Compensation	9.6	11.1
Reinsurance - Nonprop Assumed	2.6	1.0
Other/Products Liability	4.7	7.5
Commercial Multiple Peril	2.3	1.9
Medical Malpractice	-2.7	-3.5
Commercial Auto Liability	0.4	0.7
Homeowners	-0.2	-0.4
Personal Auto Liability	-3.1	-3.9
All Other Lines	-3.2	-4.6
Total Core Reserves	10.4	9.8
Asbestos & Environmental	13.7	11.2
Total	24.1	21.0

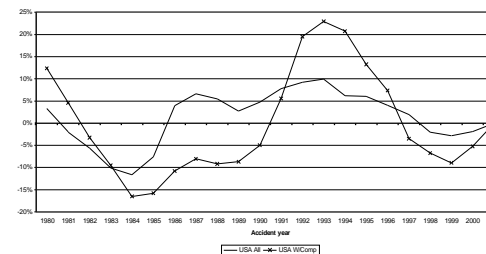


CAS_Facilitators_Guide.pdf

UK-GIRO Cycle Research US Cycle

Introduction

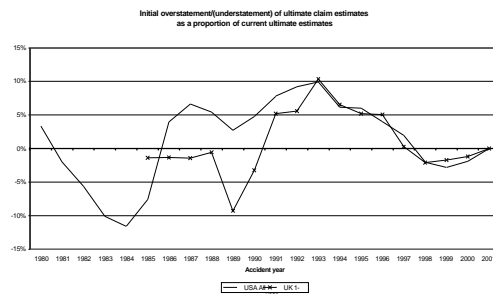
Initial overstatement(understatement) of ultimate claim estimates as a proportion of current ultimate estimates



From The Cycle Survival Kit, GIRO, 2003

UK-GIRO Cycle Research

UK Cycle



From The Cycle Survival Kit, GIRO,
2003

History of The Project

- At a discussion of possible projects for the committee, a member mentioned that COTOR is perceived as a group of ivory-tower geeks whose projects have little relevance to practicing actuaries
- COTOR members have expertise in modeling
- COTOR members would like to bridge the gap between the modelers and the practicing actuaries

History of The Project cont.

- COTOR was stimulated by Gary Venter's paper "Testing the Assumptions of Age-to-Age Factors" (PCAS 1998) and by recent events
- The project is practical
- It addresses something most actuaries are involved with: loss development triangles

Impediments to Adoption

- Toolkit seemed adequate
- Traditional methods seemed to be both necessary and sufficient
- Modeling - a "new" way of reserving
- Expensive software packages created a gulf between Excel users and those who could buy the software
- Actuarial estimates of variability of reserves – some deem them unacceptably high
- Hubris

New Reasons to Add to the Toolkit

- GIRO study indicates cycle in reserves when applying chain-ladder method
- Computers are faster, Excel skills are greater, and software packages are talking to one another
- Change to exam syllabus will increase modeling skills, especially regression
- Regression is “de facto science” in the courts

Expected Skill Level Upon Completion:

General Understanding

The Active Participant Is Expected to ...

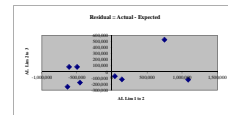
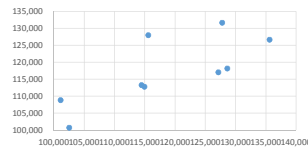
- be conversant in the basic concepts
- learn more about statistical underpinnings of estimation of liabilities using data in loss development triangles

General Understanding

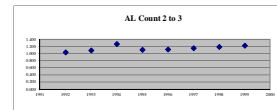
- No expectation that the attendee will be an expert after one seminar
- After the seminar, the attendee should know enough to detect who has some expertise, and who doesn't.
- After the seminar, the attendee will be better prepared to decide if regression should be added to professional toolkit.

Visual Testing

- Many tests are graphical



Residuals - Actual - Expected	1 to 2	2 to 3
Accident Half-Year	121,951	(75,353)
1998-2	94,278	(142,811)
1999-1	(199,926)	67,055
1999-2	(135,091)	(184,490)



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Applications of Statistical Testing

- Common methods have assumptions which can be tested
- Model Testing helps one choose between options
- Statistical methods supplement but do not replace judgment

Benefits to the Participants

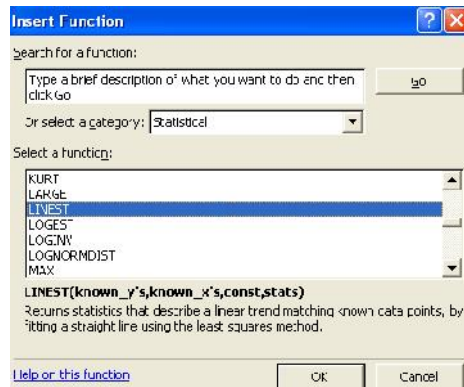
- Improves breadth of skills by adding knowledge of regression
- Increased understanding of uncertainty of estimates of indicated reserves
- Increased understanding of assumptions underlying reserving methods

Regression

- Mathematical technique used to estimate the parameters of a model
- Simple bivariate case (line in one independent variables)
 $Y = mX + b$
- Excel Functions
 - Function wizard
 - LINEST and other functions (intercept, slope, trend)

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Tools in Excel



Regression Tools in Excel



Excel Regression Functions

- SLOPE
- INTERCEPT
- STEYX
- TREND
- FORECAST
- RSQ
- LINEST

What the Course Will Not Cover

- Extrapolation of the tail beyond the range of the data
- *How* to incorporate additional information (other than inflationary trend information) beyond a single entity's data
 - Prior information is often qualitative
 - Actuarial judgment is crucial
 - The course will help determine *when* prior information is most useful

Class Schedule

8:30	Optional Classes
	Class A – The mathematics of regression
	Class B - The reserving problem
9:30	Break
10:00	Session 1
	1. Discuss triangles of cumulative loss costs
	2. “Actuarial methods” and Excel functions as algorithms
	3. Multiple algorithms and “The Reserving Problem”
11:45	Break for lunch
1:00	Session 2
	4. Residuals: Structure and scale as tests of algorithms
2:00	Independent work in Excel
3:15	Break
3:30	Session 3
	5. Model design

Tools For Trainers



Facilitators Guide

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Excel regression functions	A-5 to A-19

Facilitators Guide

- User friendly
- Walks through the spreadsheets used for the course
- Presents the concepts that will be taught
- Presents recommendations for teaching the concepts in the course

Each Section of Class Has Learning Objectives

Learning Objectives

At the end of Section 4, the *participants* should be able to:

- 4.1 Examine a triangle of data and note its qualities as a set of "actual" observations.
- 4.2 Adjust a triangle of data (e.g., by using incremental data) and discuss how the adjusted data is more or less appropriate as a set of "actual" data.
- 4.3 Give examples of real-world problems for which the linear assumption of regression is clearly inappropriate. This may be difficult, but if it is, it simply shows the usefulness of linear models.
- 4.4 Contrast algorithms applied to paid data with algorithms applied to incurred data (paid+case reserve).
- 4.5 List five ways that patterns in the residuals might indicate that one or more assumptions is not appropriate.
- 4.6 Create a chart in Excel of a set of residuals and comment about what the chart says about the appropriateness of the assumptions.
- 4.7 Discuss the argument that big differences between actual and expected imply a poor tool for forecasting.

The Excel Files

Excel Files	File	Contents
	AL Min Count	Auto Liability counts for minimum limits policies
	AL Min Limit	Auto Liability paid losses for minimum limits policies
	AL Schedule P Incd	Auto Liability incurred losses from aggregate Schedule P data
	AL Schedule P Paid	Auto Liability paid losses from aggregate Schedule P data
	Mack XS Cas	Excess Casualty losses – General Liability reinsurance

The Structure of the Files

- **Triangle** and **Wtd Avg** worksheets are nearly identical.
- The data and formulas are the same, but the **Wtd Avg** contains more charts at the bottom.
- Think of the Triangle worksheet as the place to create new charts and exhibits during the class.
-
- The **Wtd Avg** worksheet is the "clean" copy that doesn't change.

The Excel Files

Cumulative Losses Paid (Thousands) at Six-Month Reviews

Accident Half-Year	1	2	3	4	5	6	7	8
1998-2	380	1,218	1,372	1,361	1,364	1,364	1,365	1,388
1999-1	617	1,928	2,172	2,230	2,247	2,253	2,322	2,356
1999-2	1,023	2,213	2,723	2,759	2,763	2,765	2,801	2,694
2000-1	3,082	7,462	8,717	8,927	8,874	8,957	8,817	
2000-2	2,998	7,385	8,951	9,169	9,343	9,164		
2001-1	3,081	9,179	10,900	11,118	11,090			
2001-2	3,745	9,339	11,044	11,141				
2002-1	2,483	7,311	9,305					
2002-2	2,522	6,877						
2003-1	1,320							

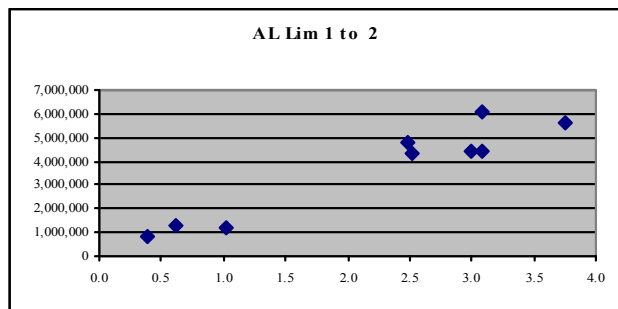
The Excel Files cont.

	<u>1 to 2</u>	<u>2 to 3</u>	<u>3 to 4</u>	<u>4 to 5</u>
Weighted Avg:	2.655	1.199	1.018	1.003
Avg of Last 3:	2.722	1.214	1.018	1.004
Selected:	2.655	1.199	1.018	1.003
Cumulative Factors:	3.210	1.209	1.009	0.991

Some Topics Covered



Selecting Weighted Average Factors Like a Regression



Regression in Excel



Selecting Weighted Average Factors Like a Regression

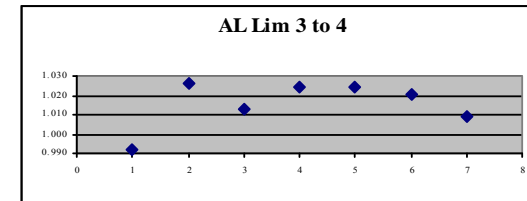
LINEST ARRAY TABLE AL Lim 1 to 2

Slope	1.561	208,763	Intercept
Slope Std Error	0.190	475,430	Intercept Std Error
R Square	0.906	658,589	SEy
F Statistic	67.154	7.000	Degrees of Freedom
Reg SS	2.91E+13	3.04E+12	Res SS

Assumption: Underlying Selected Average Representative

Assumption :

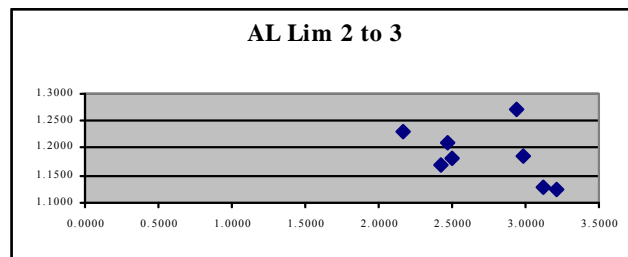
Selecting an average of the last three age-to-age factors assumes that older factors don't represent the future, but new factors do



Assumption: No Correlation

Assumption :

Loss development factor sets are not correlated



Multiple Algorithms

- Incorporate a diversity of viewpoints
- Can improve the quality of your estimate
- Help quantify the variability of your estimates, and give you a range of reasonability for the estimates
- Different estimates can spur discussions with other areas
 - What is driving the difference.
- If a method relying on historical weighted average is out of range with other estimates, a discussion with the claim department is in order to learn if anything in their methodology is changing.
- Could point out areas where one of the algorithms needs to be revised.

Residuals

- Residual = Actual – Estimated Value

Accident Half-Year	<u>1 to 2</u>	<u>2 to 3</u>	<u>3 to 4</u>
1998-2	209,602	(89,062)	(35,671)
1999-1	288,380	(138,234)	18,394
1999-2	(502,745)	70,421	(13,700)
2000-1	(720,812)	(227,981)	53,550
2000-2	(573,243)	98,245	56,888
2001-1	1,000,580	(103,043)	22,289
2001-2	(602,960)	(151,316)	(101,750)
2002-1	718,593	540,969	
2002-2	182,606		
2003-1			
Total	(0)	0	(0)

Independent Work With Excel Files

- Participants work with the Excel spreadsheets on their own.
 - constructing charts,
 - using the regression formulas
 - further analyzing the data and residuals in the Excel spreadsheets.
- Give participants the Learning Objectives, so they can focus on the salient points.

Class Pre-work

- Participants should download Excel files containing loss development data for class
- Participants can incorporate own data into file
- Participants are expected to bring laptop to class

New Tools Available – R ChainLadder

- For those familiar with R, the R ChainLadder package will provide some of the graphs and diagnostics covered in this session.
- We will show a snapshot from the packages documentation file (available from www.r-project.org).

Graphs from R ChainLadder Package

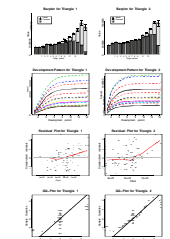


Figure 4: Summary and diagnostic plots from the R ChainLadder package.

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Questions?