SOCIETY OF ACTUARIES

Health Spring Meeting
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Session # 29: Stochastic and Artificial Intelligence Models in Health Insurance Continental Breakfast

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Stochastic Tools – “Paste, Click & Print”

SOA 2008 Spring

Session 29 – Stochastic and Artificial Intelligence Models in Health Insurance Continental Breakfast

Thursday May 29, 2008

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Agenda

- How can Actuarial Reserving Process Add Value to Enterprise Risk Management (ERM) Process
- Comparison of Process to Develop Reserve Results
- Comparison of Methods to Develop Reserve Results
- New Information using Stochastic

Actuarial Claim Reserve Processes Can Add Value to Enterprise Risk Management

- **In order for the actuarial reserve process to add value to ERM, the reserve process needs to be completed faster, more accurate and less cost.**

- **How can this be accomplished using the current deterministic approach?**

Comparison of Methods to Report Reserves

- **Current Deterministic Method**
  - Deliverable: accurate reserve reported as fast as possible
  - Reserves due by? Typically, 3 to 5 business days
  - How accurate? Want recast error rate as low as possible
  - Per lag cell, how much time is required to calculate the reserve vs. analysis time?
  - How does one go about developing projected pmpm's? Using trend indexes and actuarial judgment
  - How many FTE's?

- **Stochastic Method**
  - Deliverable: accurate reserve reported as fast as possible
  - Simultaneously complete stochastic method AND deterministic method
  - Business rules enable **2 reserve lag table completed every 5 minutes.** By scaling blades using **Microsoft HPC** can complete any number of lag cell e.g. 24 or 48 "lags" per hour with no human intervention etc.
  - Business rules at line of business and type of service level encapsulate experience with a line. Using judgment actuary selects projected PMPMs, does not calculate them
  - Stochastic modeling and simulation gives new information not available under traditional method e.g. sensitivity analysis

Comparison of Methods to Develop Reserve Results

- **Deterministic Method**
  - Manual using Excel and/or calculator
  - Labor intensive
  - Significant reliance on actuarial experience
  - Sensitivity analysis via multiple techniques and scenarios
  - Worst case reserve – not available
  - Provision for Adverse Deviation to guard against aggregate error
  - Reserve justification to accounting auditors and regulators (state, IRS) is supported by multiple methods and other reports.

- **Stochastic Process**
  - Hands-off process
  - Technology Intensive
  - Reliance upon mathematical optimization and business rules with actuarial judgment the final layer
  - Results are business rule driven, any deviations encapsulated in actuarial judgment are identifiable and quantifiable
  - Results are reproducible and auditable
  - Sensitivity analysis
  - Worst case reserve at 95%, 99%and 100% probability levels via business rules applied to econometric model with 10,000 path simulation
  - Projection of trends up to 24 months past valuation date.
  - Provision for Adverse Deviation is measured by current volatility or long run volatility
  - Reserve justification is supported by distribution, business rules, sensitivity analysis and actuarial judgment

New Information using Stochastic Reserve Model

- **Deterministic model is completed as part of stochastic method and for comparative purposes**
- **New Information from Stochastic Model – Reserves**
- **New Information from Stochastic Model – Sensitivity Analysis**
- **New Information from Stochastic Model – Completion Factors**
- **New Information from Stochastic Model – Projected PMPMs**

New Information from Stochastic Model - Reserves

Using pure determinsitic reserve technique, the 95th or 100th percentile worst case reserse information is not available except for using actuarial judgement.

With PROSRM worst case reserve estimate is available and used in picking booked final reported reserve.

This is not available from determinstic method, used PROSRM at 95th to give relative probability.

Valuation Date	**Dec-05**	
Run date and time stamp	11/19/07 5:20 PM	
		Probability
Deterministic 4 of 6 Reserve Result	4,089,473	90.29%

Reserve Required at 95 th Percentile

$ 4,529,311

Client Rule Summary Results

	Result	Probability
Upper Bound Reserve Estimate	4,529,311	100.00%
Client Reserve Selected Estimate	4,295,333	94.83%
Lower Bound Reserve Estimate	4,102,182	90.57%
MACRO MODEL Rule Reserve Estir	4,352,653	96.10%

December 2005 Reserve Restated September 20

4,392,745

This is from September 2006 and helps confirm reserve accuracy and in tuning business rules.

Client select is based on business rules. Accuracy will be a function of how well tuned the business rule. Also, there are many forms of business rules e.g. choose reserve range such that no more than 10% relative error or choose for each individual month lower bound at 50%, select at 55% and upper bound at 95%.

Business rules and business tuning and monitoring will be primary goal.

Corporate Rule Summary Results

	Result	Probability
Upper Bound Reserve Estimate	3,928,471	86.73%
Corporate Reserve Selected Estima	3,928,471	86.73%
Lower Bound Reserve Estimate	3,928,471	86.73%
MACRO MODEL Rule Reserve Estir	3,928,471	86.73%

Corporate rule summary results area functions as second set of independent calculations to fullfill Enterprise Risk Management process or you could just use it as a what if analysis area.

New Information from Stochastic Model – Sensitivity Analysis

	Lower Bound Percentil	CF/ PMPM Ind	Selectec Percenti	CF/ PMPM Ind	Upper Bound Percenti	CF/ PMPM Ind	Lower Bound Percenti PMPM	Selectec Percenti PMPM	Upper Bound Percentile PMPM
Duration-12 thru -4	N/A		N/A		N/A		N/A	N/A	N/A
Duratior Jan-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	149.59	149.95	150.33
Duratior Feb-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	118.70	119.03	119.33
Duratior Mar-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	123.91	124.23	124.55
Duratior Apr-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	115.36	115.67	115.96
Duratior May-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	114.33	114.61	114.90
Duratior Jun-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	113.15	113.45	113.73
Duratior Jul-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	108.07	108.35	108.64
Duratior Aug-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	124.31	124.65	124.94
Duratior Sep-05	0.52	Stochastic CF	0.50	Stochastic CF	0.48	Stochastic CF	112.87	113.14	113.42
Duratior Oct-05	0.50	chastic PMPM	0.80	chastic PMPM	0.95	hastic PMPM	105.37	109.92	114.34
Duratior Nov-05	0.90	chastic PMPM	0.92	chastic PMPM	0.95	hastic PMPM	111.95	112.80	114.40
Duratior Dec-05	0.75	chastic PMPM	0.85	chastic PMPM	0.95	hastic PMPM	102.62	104.72	108.40
Duratior Jan-06	0.47	chastic PMPM	0.50	chastic PMPM	0.95	hastic PMPM	151.34	151.97	167.21
Duratior Feb-06	0.49	chastic PMPM	0.50	chastic PMPM	0.95	hastic PMPM	120.23	120.41	132.05
Duratior Mar-06	0.20	chastic PMPM	0.25	chastic PMPM	0.95	hastic PMPM	119.99	121.16	138.19

New Information from Stochastic Model – Completion Factors

Stochastic M	Model Run Date and Time
A 1.00.00	11/13/2007 0:00

Client Identif	AB10000
Product	PROSRM_v1
Client Name	Big Health Care Insurer
Entity Name	Big Client
Account Nur	A12345
Contract Nu	C12345
Line of Busi	PPO
Benefit Plan	Deducttible 5000
Location	NC
Covered Gro	Underwritten
Type of Ser	Hospital Inpatient
Data Type:(p	Net Payments
Data Freque	12
CF Duration	3
Valuation/Re	12/15/2005

Long Run Model Statistics

Long Run Mean: -0.00566
Long Run Volatility: 0.070711
Note: Volatility is expressed as a percentage of mean. When mean is 0.0%

Volatility Drivers:
Volatility is primarily driven by unexpected, non permanent shock

New Information from Stochastic Model of Completion Factor that is not available in deterministic: Long run mean and volatility.

New Information from Stochastic Model of Completion Factor that is not available in determinsitic: volatility change "one time shock" or or permanent.

Original Input Data 0.919289 0.921064 0.933101 0.930207 0.91333 0.898695 0.887532

Note: Trend Factors below are of form "(1+trend factor)" for direct multiplication. For Annual Trend raise to 12th power minus 1 e.g. [(1.005)

	Monthly Trend Dis	Duration0
1	100 th Percentile	1.209076
0.99	99 th Percentile	1.113895
0.98	98 th Percentile	1.10008

New Information from Stochastic Model of Completion Factor that is not available in deterministic method: Short run completion factor trend distribution.

New Information from Stochastic Model – Projected PMPMs

Stochastic Mod	Model Run Date and Time		
A 1.00.00	11/13/2007 10:45		
Client Identifer	AB10000	Long Run Model Statistics	
Product	PROSRM_v1		
Client Name	Big Health Care Insurer	Long Run Mean:	0.013427
Entity Name	Big Client	Long Run Volatility:	0.083918
Account Numbe	A12345	Note: Volatility is expressed as a	
Contract Numbe	C12345		
Line of Busines	PPO	Volatility Drivers:	
Benefit Plan	Deducttible 5000	Volatility is primarily driven by non permanent shock and partlyby increase in volatility	
Location	NC		
Covered Group	Underwritten		
Type of Service	Hospital Inpatient		
Data Type:(pay	Net Payments		
Data Frequency	12		
Duration	PMPM_Projection		
Valuation/Repor	12/15/2005		

New Information from Stochastic Model of Projected PMPMs that is not available in deterministic: Long run mean and volatility incorporating claim non

New Information from Stochastic Model of Projected PMPM that is not available in determinsitic: volatility change "one time shock" or permanent.

New Information from Stochastic Model of Projected PMPMs that is not available in deterministic method:
1.) Short run trend distribution incorporating claim non indepedence.
2.) PMPM projection past valuation date.

	Original Input Data	105.672	84.78202	93.18619	148.3397	118.0599	130.0313	117.2099		431	103.0579	105.2878

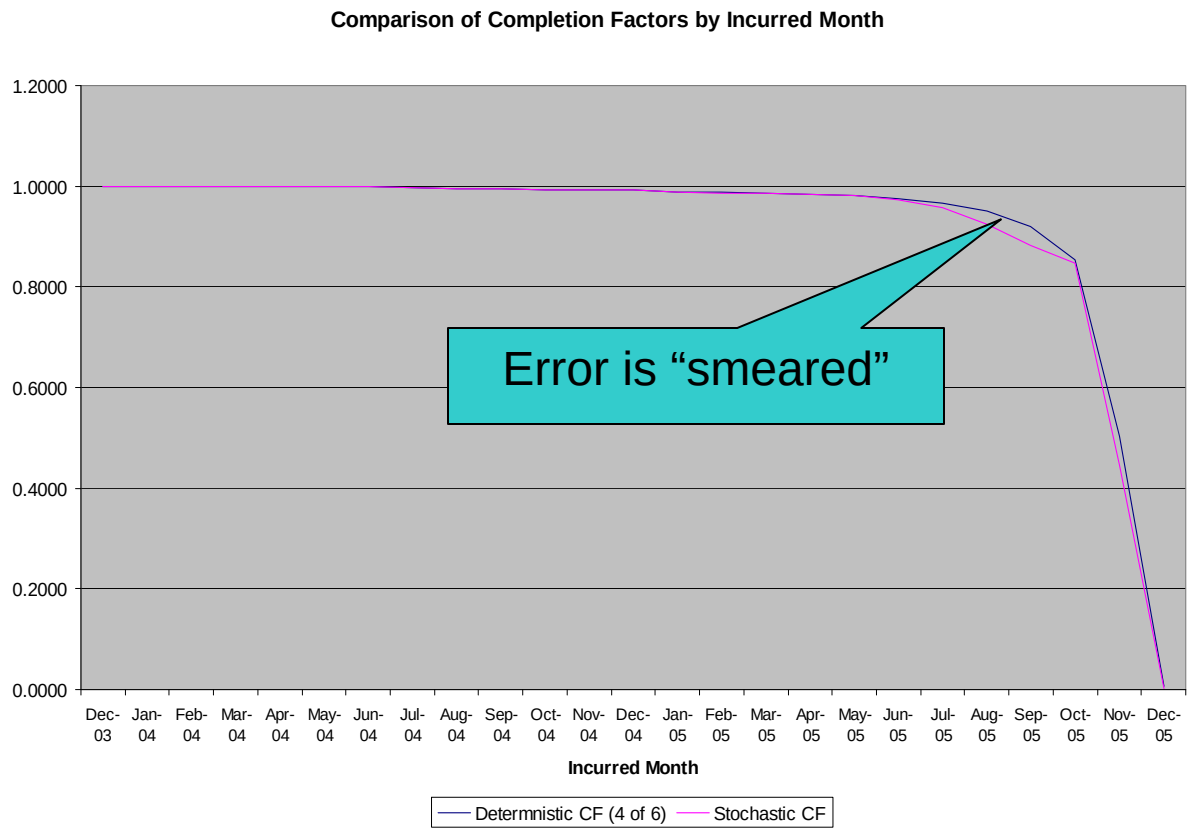
Note: For PMPM Projection Trend Factors below are of form "(1+ annual trend factor(1-month))" for d tion as derived from ([pr

	Monthly Trend Dis	Duration-2	Duration-1	Duration0	Duration1	Duration2	Duration3	Duration4	Duration5		Duration7	Duration8
1	100 th Percentile	1.267258	1.296696	1.260197	1.283176	1.297701	1.24962	1.348838	1.31045		1.343639	1.325063
0.99	99 th Percentile	1.138047	1.166012	1.154132	1.158779	1.15999	1.15906	1.158551	1.161729	1.1	153754	1.158339
0.98	98 th Percentile	1.120989	1.144048	1.134086	1.141442	1.139688	1.139557	1.140653	1.139369	1.14	39456	1.139455
0.97	97 th Percentile	1.110628	1.13345	1.122527	1.129214	1.127768	1.128384	1.12719	1.126762	1.1281	27238	1.129208

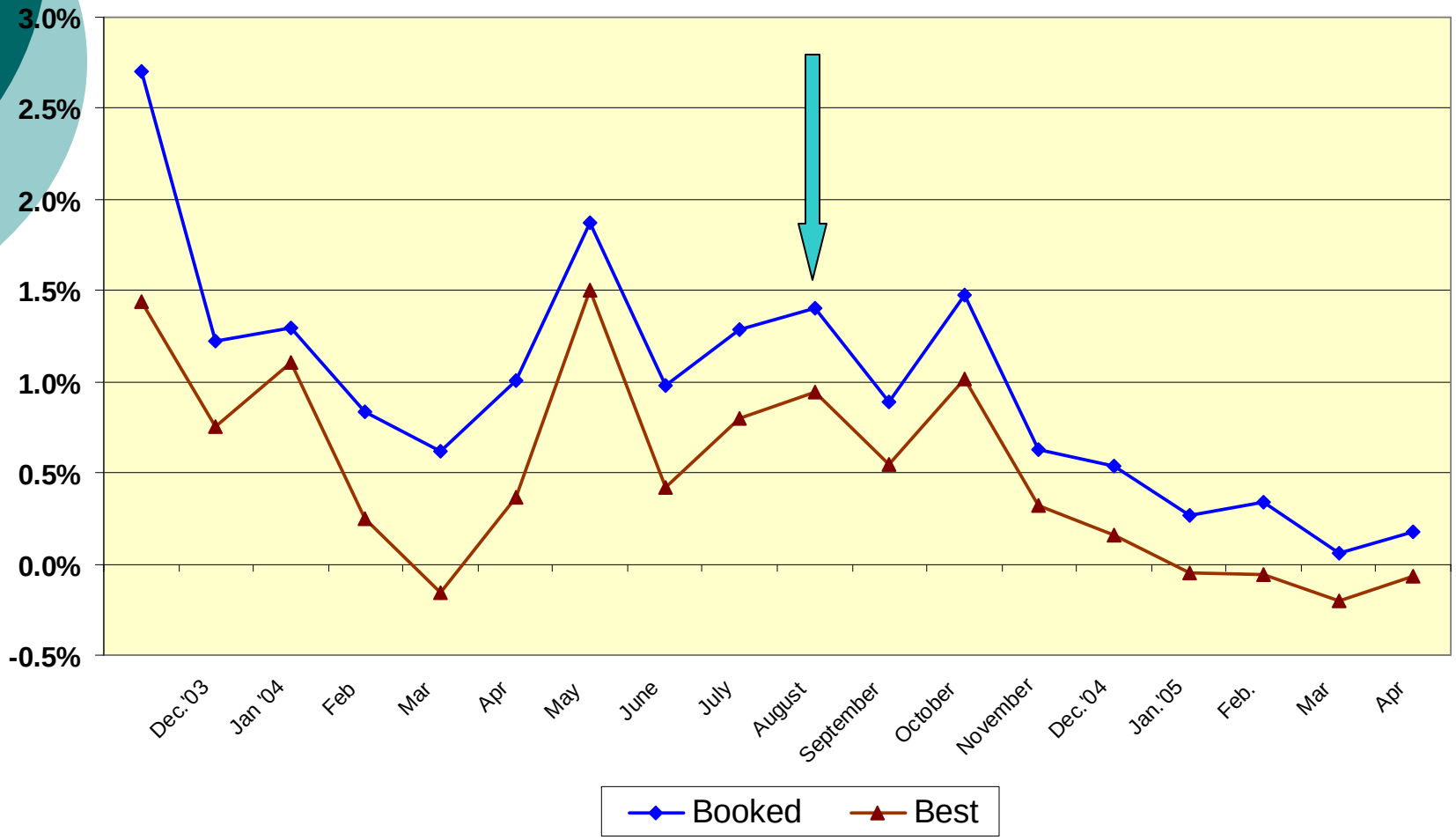
Error Comparison: Deterministic vs. Stochastic

- **Comparison of Completion Factor (CF): Stochastic vs. Deterministic**
  - Even the most responsive deterministic methods will fall victim to payment pattern instability
- **Accuracy % of Recast Prior 12 Months Incurred Claims**
  - Recast Percentage error is reduced and less volatile with stochastic

Comparison of CF: Stochastic vs. Deterministic



Accuracy % of Recast Prior 12 Months Incurred Claims
December 2002 – April 2005
Stochastic Model Applied August 2004



Demonstration of Stochastic Reserve Model – Health Claim Reserve

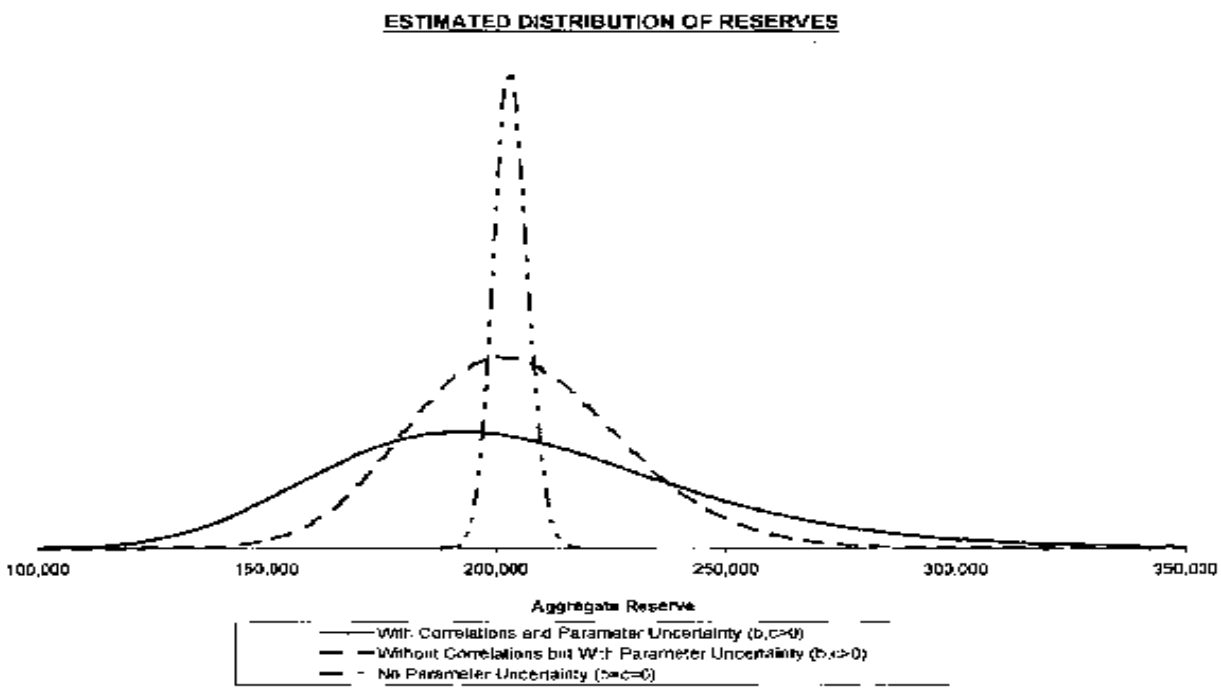
- Now demonstrate stochastic reserve model for health claim reserve

Demonstration of Stochastic Reserve Applied to Casualty Society Cross Correlation in Reserves Paper

- Demonstrate stochastic model results as applied to CASACT paper “Estimating and Incorporating Cross Correlation In Reserve Variability”

CASACT paper Estimating and Incorporating Cross Correlation In Reserve Variability

Exhibit 8



Stochastic Reserve Model Results based on CASACT paper Estimating and Incorporating Cross Correlation In Reserve Variability

Valuation Date		**Dec-91**	
Run date and time stamp		4/15/2008	
			Probability
Deterministic 4 of 6 Reserve Result	$	267,006	98%

Client Rule Summary Results

		Result	**Probability**
Upper Bound Reserve Estimat	$	204,775	75%
Client Reserve Selected Estim	$	202,437	74%
Lower Bound Reserve Estimat	$	199,608	73%
MACRO MODEL Rule Reserve	$	199,608	73%
Worst Case Reserve Liability @ 0.95	$	272,324	

Disadvantages of Stochastic Tool Approach

- Likely to asked to do more work……
- Others?

Summary of Demonstration

- **Just saw live demonstration of stochastic health claim reserve model combined with deterministic reserve methodology. What's your comfort level now?**
- **Stochastic reserve models are key tool for enterprise risk management.**
- **New information available via reserve stochastic modeling enables more accurate estimation process with reduced error rate in compressed time.**
- **The operational process to develop claim reserve estimates is favorable impacted/enhanced in terms of speed, accuracy, consistency as compared to current deterministic methodology.**