



Stochastic Tools – “Paste, Click & Print”

SOA 2008 Spring
Session 29 – Stochastic and Artificial Intelligence
Models in Health Insurance Continental Breakfast
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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



Valuation Date Dec-05

Run date and time stamp 11/19/07 5:20 PM

Deterministic 4 of 6 Reserve Result 4,089,473

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

Using pure deterministic reserve technique, the 95th or 100th percentile worst case reserve 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.

Probability
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.

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%

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

New Information from Stochastic Model – Completion Factors

Stochastic 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 Nur C12345

Line of Busir PPO

Benefit Plan Deductible 5000

Location NC

Covered Grc Underwritten

Type of Ser Hospital Inpatient

Data Type:(r 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 deterministic: volatility change "one time shock" or or permanent.

Original Input Dat: 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)¹² - 1]

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 Model Run Date and Time
 A 1.00.00 11/13/2007 10:45

Client Identifier AB10000
 Product PROSRM_v1
 Client Name Big Health Care Insurer
 Entity Name Big Client
 Account Number A12345
 Contract Number C12345
 Line of Business PPO
 Benefit Plan Deductible 5000
 Location NC
 Covered Group Underwritten
 Type of Service Hospital Inpatient
 Data Type:(pay Net Payments
 Data Frequency 12
 Duration PMPM_Projection
 Valuation/Report 12/15/2005

Long Run Model Statistics

Long Run Mean: 0.013427
 Long Run Volatility: 0.083918
 Note: Volatility is expressed as a

Volatility Drivers:

Volatility is primarily driven by non permanent shock and partly by increase in volatility

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 deterministic: 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 independence.
- 2.) PMPM projection past valuation date.

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

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

Monthly Trend Dis	Duration-2	Duration-1	Duration0	Duration1	Duration2	Duration3	Duration4	Duration5	Duration6	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	1.153754	1.158339	
0.98 98 th Percentile	1.120989	1.144048	1.134086	1.141442	1.139688	1.139557	1.140653	1.139369	1.139456	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	1.129208	

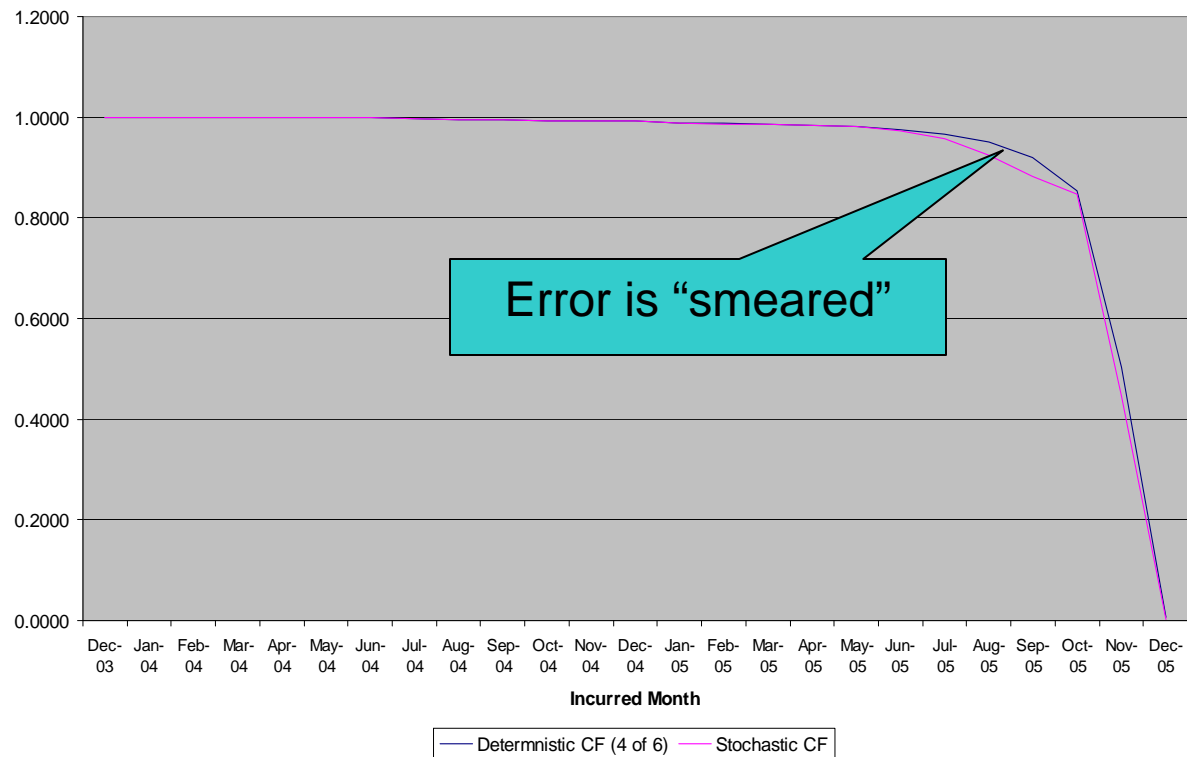


Error Comparison: Deterministic vs. Stochastic

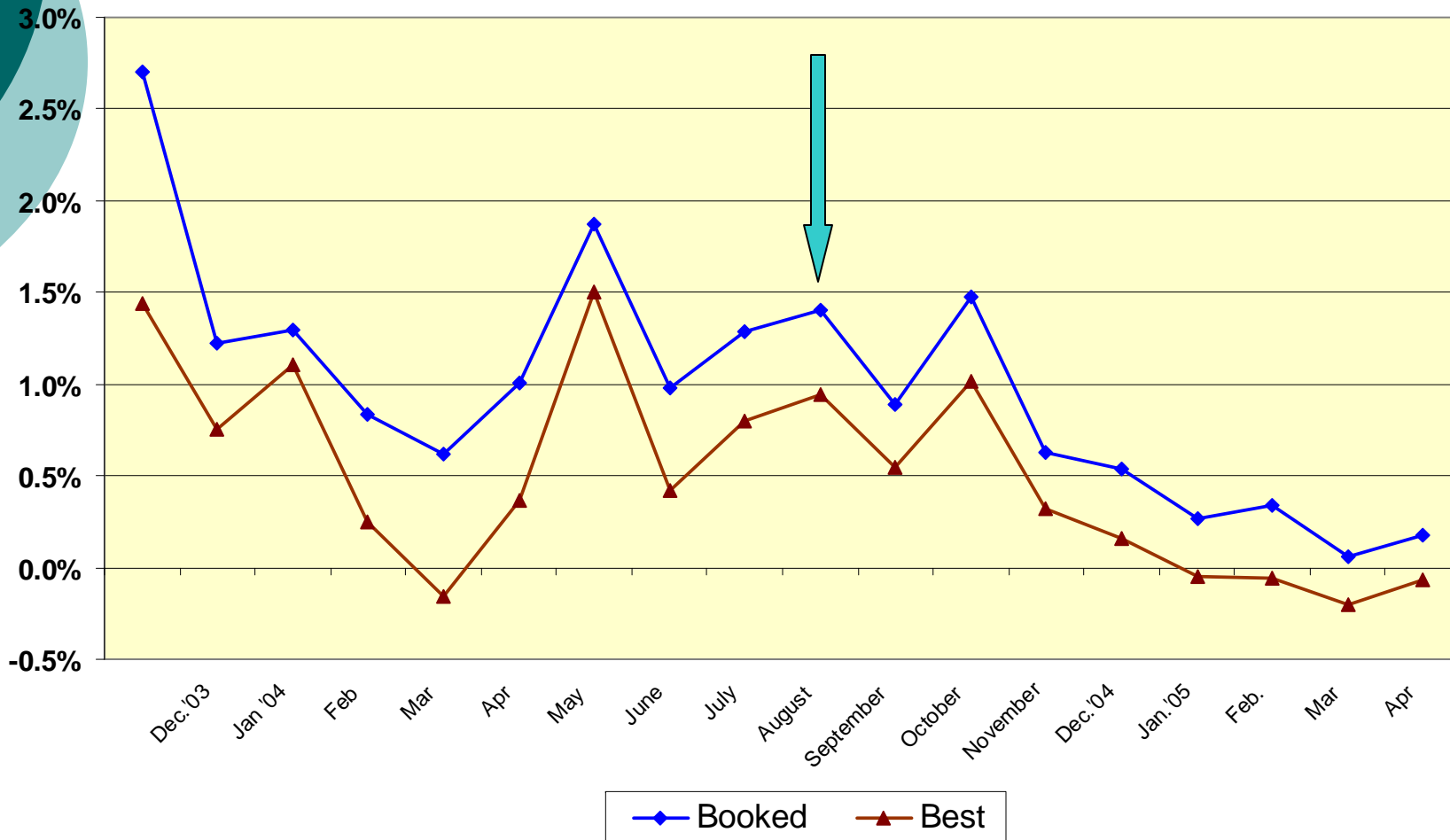
- **Comparison of Completion Factor (CF): Stochastic vs. Deterministic**
 - Even the most responsive deterministic methods will fall victim to payment pattern instability
- **Accuracy % of Recast Prior 12 Months Incurred Claims**
 - Recast Percentage error is reduced and less volatile with stochastic

Comparison of CF: Stochastic vs. Deterministic

Comparison of Completion Factors by Incurred Month



**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

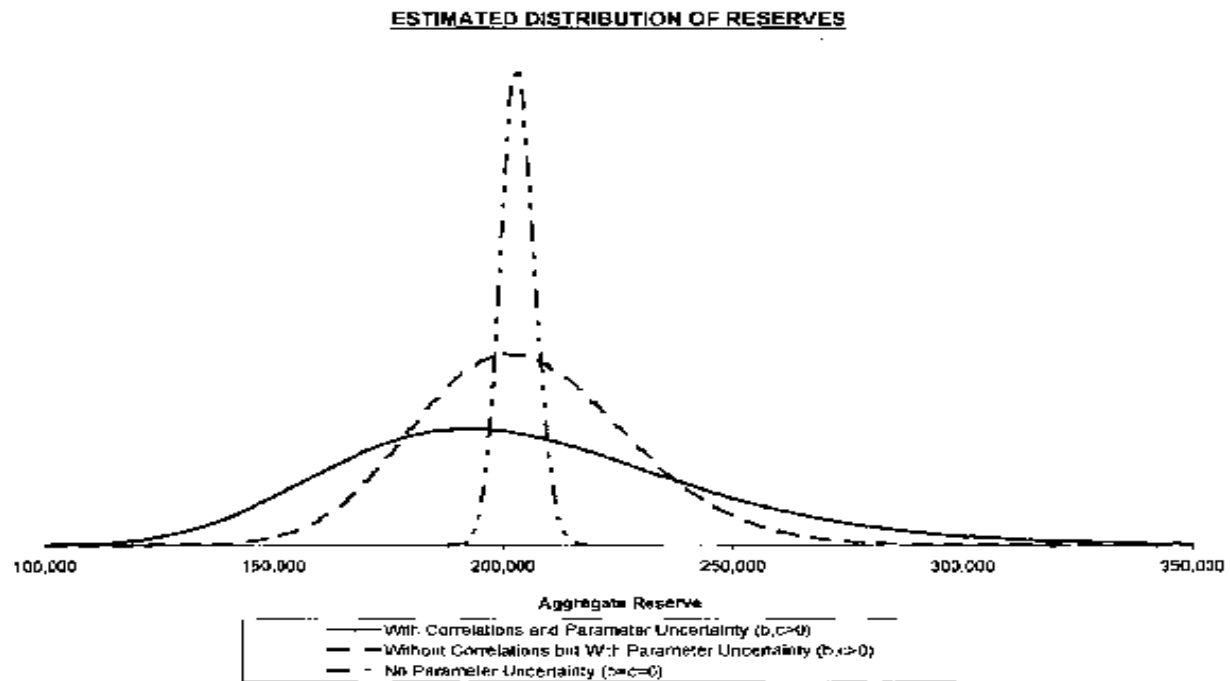


Demonstration of Stochastic Reserve Applied to Casualty Society Cross Correlation in Reserves Paper

- 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	
Deterministic 4 of 6 Reserve Result	\$ 267,006	Probability 98%

Client Rule Summary Results

	Result	Probability
Upper Bound Reserve Estim	\$ 204,775	75%
Client Reserve Selected Estim	\$ 202,437	74%
Lower Bound Reserve Estim	\$ 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 be 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.**