New Frontiers

A ROUND-UP OF EMERGING RESERVING TECHNIQUES

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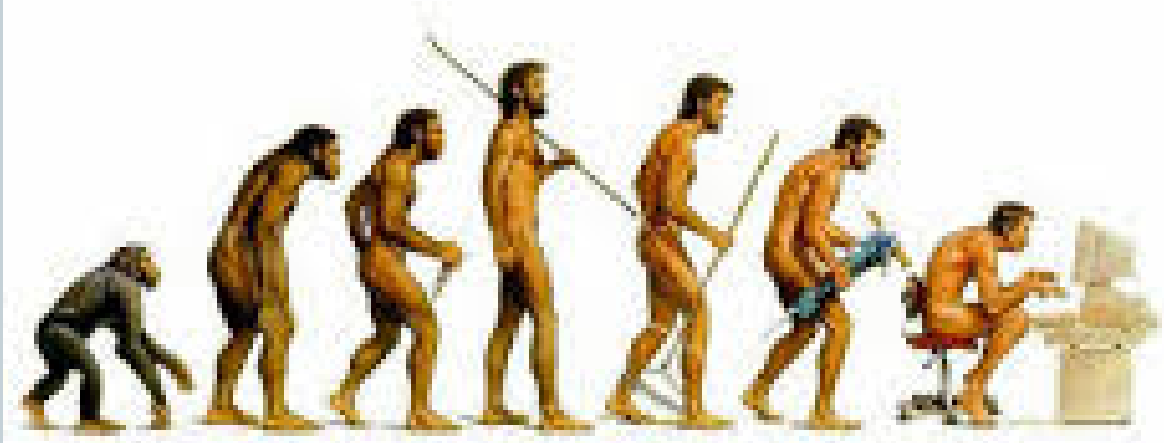
Agenda

- Triangle-free Methods
- Simple Approach for Separate Estimation of Pure IBNR and IBNER

Triangle-Free Reserving



Exposure-based -> Chain-Ladder ->Adjusted CL -> Blended - > Stochastic -> ?

Data Used in Reserving

	What We Have	What We Use
Policy Level	Name, Location, Age, Gender, Inception/Expiry dates, exposure (premium, sum-insured, payroll, sales), risk details (car make, model)	Total Exposure per Accident Period
Claim Level	Loss description, Accident / Reported/Settlement dates, Transaction dates, payments, expenses, case reserves - changes, status...	Aggregate claim movements by accident and development periods

Sophisticated Techniques on Limited Data

Bornhuetter-Ferguson

BERQUIST-SHERMAN

Adler-Kline

Mack

Over-Dispersed Poisson

Hoerl Curves

Bootstrapping

Bayesian

But we are still stuck with….

Use More Information

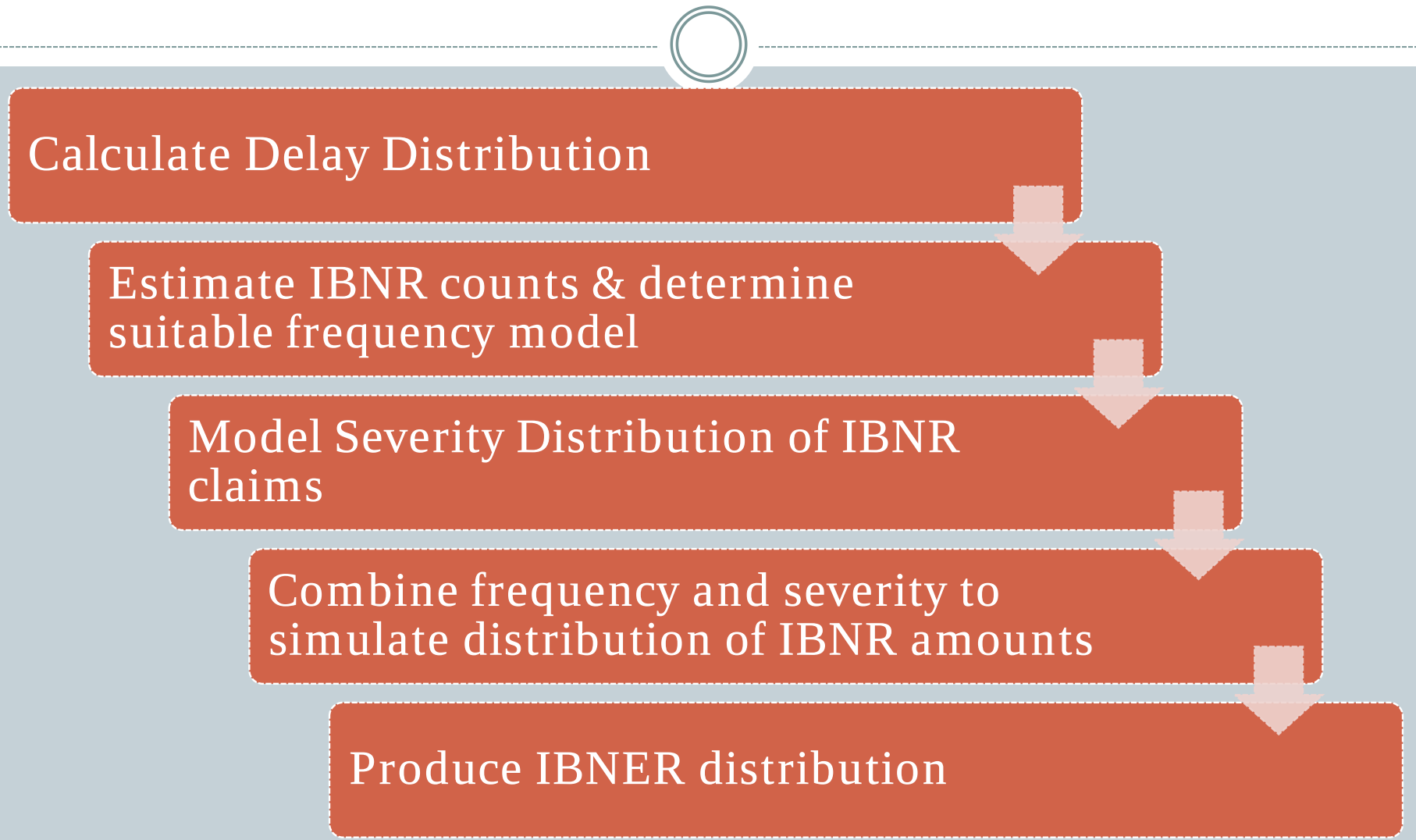
- Some progress in going beyond triangles
  - Antonio & Plat's Paper – Micro-level Stochastic Reserving for General Insurance – May 2012
  - Pietro Parodi's Paper - Triangle-free Reserving : A non-traditional framework for estimating reserves and reserve uncertainty – February 2013

Parodi's Framework

Parodi's Framework

- Uses more claim-level information
  - Reporting delays
  - Reserve movement of claims
  - Claim sizes
  - Ratio of outstanding to incurred amount
  - Type of claims
- Produces the full distribution of reserves
- Separate distributions for pure IBNR (frequency and severity), IBNER and Unexpired Risk Reserve

Parodi's Framework



Parodi's Framework

Calculate Delay Distribution

- Use historical data of reporting delays
  - Adjust for truncating effect
- May use Exponential distribution
- Or use the empirical distribution with suitable assumptions beyond truncation point
- May model different delays for "large" and "attritional" losses

Parodi's Framework

Estimate IBNR Counts & Frequency Distribution

- Use delay distribution to calculation proportion of unreported claims
- Use actual reported claim counts to calculate IBNR counts
- Assume a Poisson or Negative Binomial distribution for the IBNR counts

Parodi's Framework

Model IBNR Severity Distribution

- Different from overall severity distribution as loss sizes will be influenced by time of occurrence and reporting due to:
  - Change in business mix
  - Claim inflation
- Open claims need to be adjusted for IBNER *(more on this later…)*
- Trend the past claims (closed & open) to current levels
- Use the trended claims to create a "kernel severity distribution"

Parodi's Framework

Simulate IBNR Distribution

- Simulate number of IBNR claims from IBNR count distribution
- Simulate the occurrence time of each IBNR claim using the delay distribution
- Based on the occurrence time of IBNR claim and kernel severity distribution, determine the appropriate severity distribution for each IBNR claim
- Simulate the size of each IBNR claim and aggregate to get total IBNR distribution

Parodi's Framework

Produce IBNER Distribution

- Use the development of historical claims to calculate the IBNER factor
- Use GLM to determine the dependence of IBNER factor on claim features like development year, claim size, proportion of outstanding, type of claim, etc. (or simply create empirical distribution of IBNER factors for 1 -2 claim characteristics)
- Use the fitted GLM model / empirical distribution to simulate IBNER amounts for each open claim
- Aggregate the simulated amounts for all open claims and repeat simulation to create IBNER distribution

Parodi's Framework

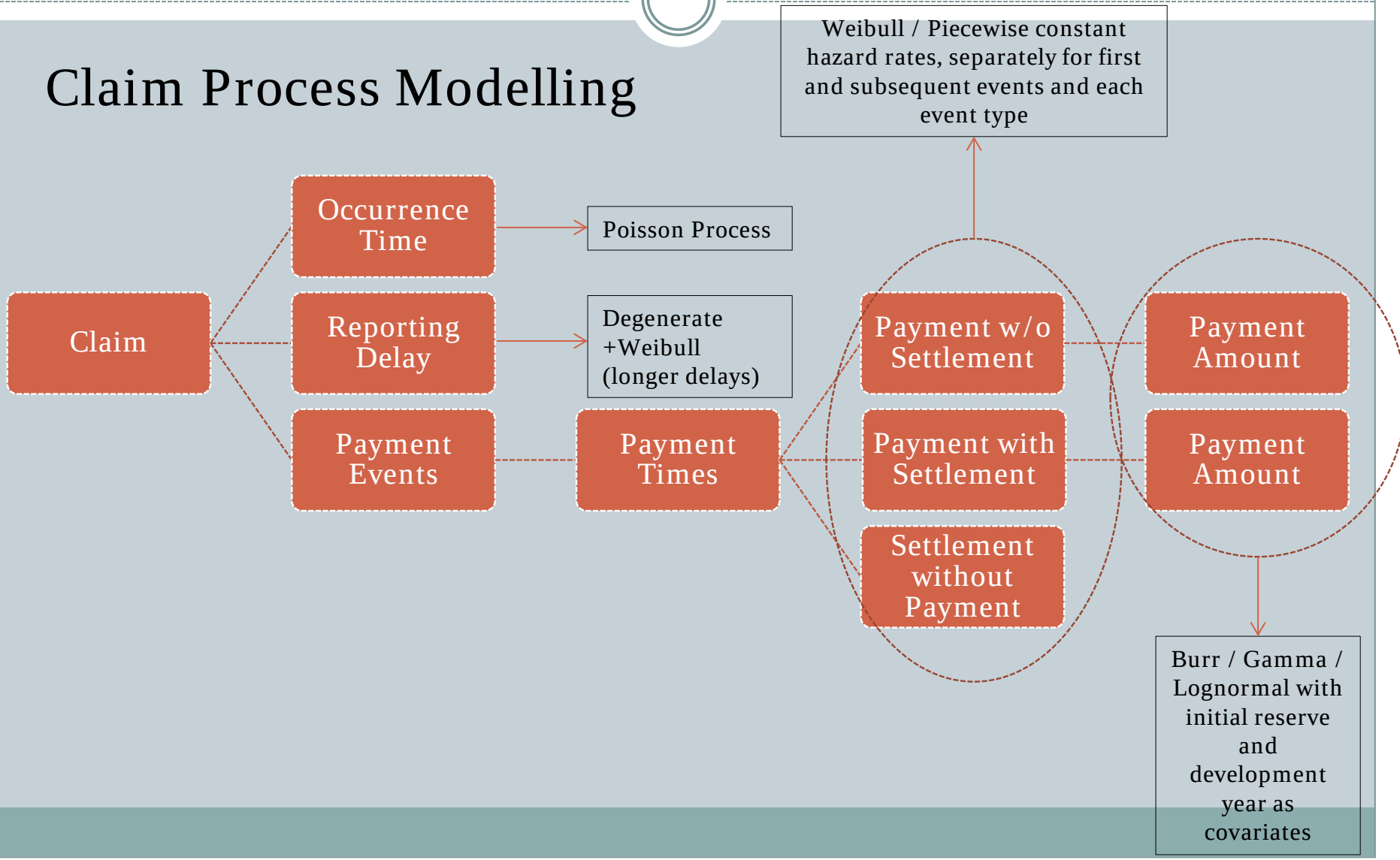
Aggregate Reserve Distribution

- We can assume independence of pure IBNR claims and open claims and therefore independence of IBNR and IBNER distributions
- We can also use a similar method to estimate the Unexpired Risk Reserve distribution.

Antonio & Plat

Antonio & Plat

Claim Process Modelling



Antonio & Plat

Simulate number and occurrence time of IBNR claims

Simulate reporting delay for each IBNR claim

Simulate initial reserve amount (empirical distribution)

For both IBNR and RBNS claims simulate payment event times

Simulate the event type and payment

Antonio & Plat

- Out of sample test on General Liability data shows better estimates for this model
- More testing required – seems to over-fit using piecewise functions
- Parameter uncertainty can be modelled by simulating parameters from a normal distribution in each simulation

Separate IBNR & IBNER Estimation

Schlemmer & Tarkowski

IBNR & IBNER Estimation

We welcome back our triangle!

Paid Loss Triangle

Accident Year	Development Years ----> 1	2	3	4	5	6	7	8	9	10
2002	1,25,62,376	2,58,62,513	2,84,67,263	2,95,75,021	3,00,91,230	3,00,73,026	3,01,04,946	3,01,66,426	3,01,86,326	3,01,89,073
2003	1,46,19,720	2,54,02,485	2,71,55,996	2,79,46,880	2,82,24,494	2,84,81,593	2,84,18,174	2,84,41,572	2,85,01,185	
2004	99,59,858	1,54,36,434	1,63,98,604	1,66,82,005	1,68,08,181	1,68,17,113	1,68,30,511	1,68,33,318		
2005	66,33,610	1,10,07,035	1,14,07,596	1,15,91,573	1,16,95,406	1,17,57,884	1,18,50,579			
2006	62,90,293	94,78,911	1,00,85,187	1,04,06,254	1,06,85,927	1,09,07,900				
2007	73,36,768	1,18,28,200	1,27,09,085	1,31,00,700	1,34,29,193					
2008	75,85,085	1,26,34,480	1,35,00,587	1,48,41,451						
2009	1,08,23,234	2,02,22,524	2,32,70,335							
2010	1,78,29,334	3,33,45,851								
2011	1,31,38,447									

IBNR & IBNER Estimation

Paid Loss Triangle For Claims Reported in first 12 months only

Accident Year	Development Years ----> 1	2	3	4	5	6	7	8	9	10
2002	1,25,62,376	2,51,18,811	2,75,54,751	2,85,88,661	2,91,00,263	2,90,85,791	2,91,16,019	2,91,65,603	2,91,82,707	2,91,85,106
2003	1,46,19,720	2,47,88,513	2,64,68,578	2,71,79,855	2,74,38,716	2,76,93,922	2,76,41,313	2,76,57,101	2,76,91,518	
2004	99,59,858	1,50,34,728	1,59,51,729	1,62,30,914	1,63,54,359	1,63,65,200	1,63,78,598	1,63,81,406		
2005	66,33,610	1,06,38,603	1,10,17,732	1,11,30,327	1,12,19,686	1,12,78,566	1,13,67,675			
2006	62,90,293	92,40,966	98,18,560	1,01,02,109	1,03,88,013	1,06,09,986				
2007	73,36,768	1,14,46,700	1,22,91,777	1,26,32,077	1,29,53,176					
2008	75,85,085	1,23,29,181	1,31,46,004	1,44,38,614						
2009	1,08,23,234	1,96,05,018	2,25,11,712							
2010	1,78,29,334	3,25,64,625								
2011	1,31,38,447									

Represents IBNER development of claims reported in 12 months

IBNR & IBNER Estimation

- Create similar triangles for claims reported in first 24 months, 36 months, etc.
- Use these triangles to estimate sets of LDF's for each case.
- Use LDF's from triangle of claims reported in first 12 months to develop AY 2011, and so on
- Can also adjust other triangle-based methods like incremental paid by exposure, count-based methods, etc.

IBNR & IBNER Estimation

Payment for claims reported after 12 months

Accident Year	Exposures	Development Years ----> 1	2	3	4	5	6	7	8	9	10
2002	50,645	0	7,43,702	9,12,512	9,86,360	9,90,967	9,87,235	9,88,927	10,00,823	10,03,619	10,03,967
2003	68,274	0	6,13,972	6,87,418	7,67,025	7,85,778	7,87,671	7,76,861	7,84,471	8,09,667	
2004	55,783	0	4,01,706	4,46,875	4,51,091	4,53,822	4,51,913	4,51,913	4,51,912		
2005	44,724	0	3,68,432	3,89,864	4,61,246	4,75,720	4,79,318	4,82,904			
2006	42,487	0	2,37,945	2,66,627	3,04,145	2,97,914	2,97,914				
2007	44,220	0	3,81,500	4,17,308	4,68,623	4,76,017					
2008	47,790	0	3,05,299	3,54,583	4,02,837						
2009	44,849	0	6,17,506	7,58,623							
2010	44,112	0	7,81,226								
2011	29,189	0									

IBNR & IBNER Estimation

Divide the incremental payments by AY exposures

Accident Year	Exposures	Development Years ----> 1	2	3	4	5	6	7	8	9	10
2002	50,645	-	14.68	3.33	1.46	0.09	-0.07	0.03	0.23	0.06	0.01
2003	68,274	-	8.99	1.08	1.17	0.27	0.03	-0.16	0.11	0.37	
2004	55,783	-	7.20	0.81	0.08	0.05	-0.03	-	-0.00		
2005	44,724	-	8.24	0.48	1.60	0.32	0.08	0.08			
2006	42,487	-	5.60	0.68	0.88	-0.15	-				
2007	44,220	-	8.63	0.81	1.16	0.17					
2008	47,790	-	6.39	1.03	1.01						
2009	44,849	-	13.77	3.15							
2010	44,112	-	17.71								
2011	29,189	-									
Simple Average			10.13	1.42	1.05	0.13	0.00	-0.01	0.12	0.21	0.01

Pure IBNR estimate for AY 2011 = 29,189*(10.13+1.42+1.05+0.13+0.00-0.01+...)

Questions?