European actuarial academy

an initiative of the 'Deutsche Aktuarvereinigung', the Dutch 'Actuarieel Genootschap', the 'Schweizerische Aktuarvereinigung' and the 'Aktuarvereinigung Österreichs'

Session 4

Business snapshots

Agenda

- Real life example of a serious error in reserving
- The difference in Paid / Incurred
  - What to do?
  - Munich Re Chainladder
- Large claims, outliers and data errors

Real life example

- This story is based on an observed case but with made up data.
- It is about a general insurance company without “actuarial reserving”.
- This can lead to serious errors:
  - The company turned out to be technically insolvent.
  - Additional external capital was needed to prevent from bankruptcy

Company details

- Company XYZ
  - Writes long term liability business
  - Started in 1998
  - Reasonable growth in 1999 – 2005
  - Premium externally derived and in line with competition
- Reserving policy:
  - Case estimates
  - IBNR 12% of premium

Operating key performance indicators

- Initial operating key performance indicators
  - Loss ratio around 75%
  - Expense ratio around 20%
  - Investment income 0% *(for sake of simplicity)*

- Initial capital 10.000
- 50% of profits paid as divident
- Tax rate 35%

Market information

- Market situation around 2002:
  - Increased number of claims
  - Highly competitive market

- Strategic evaluation at the end of 2002:
  - Increasing expenses due to regulation and law suits
  - More need for education of staff
  - Increased pressure on claim handling

Financial statements in evaluation strategy

	1998	1999	2000	2001	2002	2003	2004	2005
Premium	26,900	26,222	35,209	42,646	48,733	39,589	46,504	64,075
Paid	5,112	3,432	10,693	14,720	20,853	24,707	29,137	31,536
Change in reserve	15,349	12,713	16,542	11,674	6,939	- 7,562	- 2,131	12,870
Technical result	6,439	10,077	7,974	16,253	20,941	22,443	19,498	19,670
Expenses	5,380	5,769	7,746	9,382	12,183	11,877	12,091	16,659
Pre tax profits	1,059	4,308	228	6,870	8,757	10,566	7,407	3,010
After tax profits	688	2,800	148	4,466	5,692	6,868	4,815	1,957
Loss ratio	76%	62%	77%	62%	57%	43%	58%	69%
Combined ratio	96%	84%	99%	84%	82%	73%	84%	95%

- Increase in expenses due to external support in 2002
- Claim handling leads to reduced loss ratio
- Combined ratio stabilizes around 85%-95%
- Average 7,4% return on investment

Company XYZ; financial statements later

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Premium	26,900	26,222	35,209	42,646	48,733	39,589	46,504	64,075	53,482	46,951
Paid	5,112	3,432	10,693	14,720	20,853	24,707	29,137	31,536	42,552	30,620
Change in reserve	15,349	12,713	16,542	11,674	6,939	- 7,562	- 2,131	12,870	- 5,708	8,630
Technical result	6,439	10,077	7,974	16,253	20,941	22,443	19,498	19,670	16,638	7,701
Expenses	5,380	5,769	7,746	9,382	12,183	11,877	12,091	16,659	13,905	12,207
Pre tax profits	1,059	4,308	228	6,870	8,757	10,566	7,407	3,010	2,733	- 4,506
After tax profits	688	2,800	148	4,466	5,692	6,868	4,815	1,957	1,776	- 2,929
Loss ratio	76%	62%	77%	62%	57%	43%	58%	69%	69%	84%
Combined ratio	96%	84%	99%	84%	82%	73%	84%	95%	95%	110%

- Decrease in premium volume
- Loss ratio increased in 2007
- Combined ratio more than 100%

- Management claims temporary situation:
  one large claim accident year 2005 settled for 5.000 more than anticipated
  (= 11% of premium)

Let's look at capital position

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Solvency I	4,911	4,720	6,536	7,676	8,772	7,126	8,371	11,533	9,627	9,420
Available	10,344	11,744	11,818	14,051	16,897	20,331	22,739	23,717	24,605	24,605
Ratio	211%	249%	181%	183%	193%	285%	272%	206%	256%	261%

- Nothing wrong with the capital position
- Is it really???

Cumulative paid and age-to-age

Cumulative Paid data

	Ci1	Ci2	Ci3	Ci4	Ci5	Ci6	Ci7	Ci8	Ci9	Ci10
i=1998	5,112	8,434	11,125	12,041	13,810	16,505	18,369	18,980	19,035	19,211
i=1999	110	4,458	5,614	11,097	14,339	16,229	16,122	16,822	17,379	
i=2000	3,654	9,636	14,866	17,297	20,077	23,805	24,500	25,146		
i=2001	6,666	13,621	18,113	24,596	27,141	30,274	31,434			
i=2002	1,416	11,106	19,237	27,449	32,358	32,650				
i=2003	2,158	9,193	16,691	18,449	22,610					
i=2004	953	6,881	18,735	21,076						
i=2005	3,122	16,052	30,297							
i=2006	6,515	11,219								
i=2007	2,340									

Paid annual age-to-age factors

	Ci1-Ci2	Ci2-Ci3	Ci3-Ci4	Ci4-Ci5	Ci5-Ci6	Ci6-Ci7	Ci7-Ci8	Ci8-Ci9	Ci9-Ci10
i=1998	1.650	1.319	1.082	1.147	1.195	1.113	1.033	1.003	1.009
i=1999	40.425	1.259	1.977	1.292	1.132	0.993	1.043	1.033	
i=2000	2.637	1.543	1.163	1.161	1.186	1.029	1.026		
i=2001	2.043	1.330	1.358	1.103	1.115	1.038			
i=2002	7.843	1.732	1.427	1.179	1.009				
i=2003	4.260	1.816	1.105	1.226					
i=2004	7.217	2.723	1.125						
i=2005	5.142	1.887							
i=2006	1.722								
i=2007									

- Reasonably stable ratios

Incurred and age-to-age

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Cumulative Incurred data

	Ci1	Ci2	Ci3	Ci4	Ci5	Ci6	Ci7	Ci8	Ci9	Ci10
i=1998	17,233	17,366	18,254	18,315	18,372	18,890	19,025	19,344	19,392	19,484
i=1999	16,094	16,538	16,632	16,891	17,268	17,354	17,666	17,896	18,007	
i=2000	24,824	25,350	25,704	26,639	26,924	27,201	27,880	27,980		
i=2001	24,820	25,457	29,286	29,825	30,665	31,678	32,099			
i=2002	25,755	24,985	28,299	33,918	35,245	35,746				
i=2003	13,353	18,358	22,271	27,136	28,220					
i=2004	16,813	21,845	28,245	34,264						
i=2005	25,985	36,637	48,140							
i=2006	12,900	21,827								
i=2007	11,276									

Incurred annual age-to-age factors

	Ci1-Ci2	Ci2-Ci3	Ci3-Ci4	Ci4-Ci5	Ci5-Ci6	Ci6-Ci7	Ci7-Ci8	Ci8-Ci9	Ci9-Ci10
i=1998	1.008	1.051	1.003	1.003	1.028	1.007	1.017	1.002	1.005
i=1999	1.028	1.006	1.016	1.022	1.005	1.018	1.013	1.006	
i=2000	1.021	1.014	1.036	1.011	1.010	1.025	1.004		
i=2001	1.026	1.150	1.018	1.028	1.033	1.013			
i=2002	0.970	1.133	1.199	1.039	1.014				
i=2003	1.375	1.213	1.218	1.040					
i=2004	1.299	1.293	1.213						
i=2005	1.410	1.314							
i=2006	1.692								
i=2007									

- Age-to-age higher than 1????
- Something funny in blue!

Chainladder on paid

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Paid manual adjusted chainladder coefficients

	Ci1-Ci2	Ci2-Ci3	Ci3-Ci4	Ci4-Ci5	Ci5-Ci6	Ci6-Ci7	Ci7-Ci8	Ci8-Ci9	Ci9-Ci10	Ci10-Ult
Age-age	4.550	2.030	1.250	1.165	1.110	1.040	1.032	1.015	1.009	1.005
Multiplicative	16.579	3.644	1.795	1.436	1.233	1.110	1.068	1.035	1.019	1.010

Final outcome

	Ci1	Ci2	Ci3	Ci4	Ci5	Ci6	Ci7	Ci8	Ci9	Ci10	Ultimate
i=1998	5,112	8,434	11,125	12,041	13,810	16,505	18,369	18,980	19,035	19,211	19,307
i=1999	110	4,458	5,614	11,097	14,339	16,229	16,122	16,822	17,379	17,539	17,627
i=2000	3,654	9,636	14,866	17,297	20,077	23,805	24,500	25,146	25,524	25,759	25,888
i=2001	6,666	13,621	18,113	24,596	27,141	30,274	31,434	32,440	32,927	33,230	33,396
i=2002	1,416	11,106	19,237	27,449	32,358	32,650	33,956	35,042	35,568	35,896	36,075
i=2003	2,158	9,193	16,691	18,449	22,610	25,097	26,101	26,936	27,340	27,592	27,730
i=2004	953	6,881	18,735	21,076	24,554	27,255	28,345	29,252	29,691	29,965	30,114
i=2005	3,122	16,052	30,297	37,871	44,120	48,973	50,932	52,562	53,350	53,842	54,111
i=2006	6,515	11,219	22,775	28,469	33,166	36,815	38,287	39,512	40,105	40,475	40,677
i=2007	2,340	10,645	21,609	27,011	31,468	34,929	36,327	37,489	38,051	38,402	38,594

Total incurred	323,520
Paid as at j=10	213,362
Reserve as at j=10	110,158

Chainladder on Incurred

Incurred manual adjusted chainladder coefficients

	Ci1-Ci2	Ci2-Ci3	Ci3-Ci4	Ci4-Ci5	Ci5-Ci6	Ci6-Ci7	Ci7-Ci8	Ci8-Ci9	Ci9-Ci10	Ci10-Ult
Age-age	1.444	1.238	1.162	1.029	1.016	1.016	1.011	1.004	1.005	1.000
Multiplicative	2.252	1.559	1.259	1.084	1.053	1.036	1.020	1.009	1.005	1.000

Final outcome

	Ci1	Ci2	Ci3	Ci4	Ci5	Ci6	Ci7	Ci8	Ci9	Ci10	Ultimate
i=1998	17,233	17,366	18,254	18,315	18,372	18,890	19,025	19,344	19,392	19,484	19,484
i=1999	16,094	16,538	16,632	16,891	17,268	17,354	17,666	17,896	18,007	18,092	18,092
i=2000	24,824	25,350	25,704	26,639	26,924	27,201	27,880	27,980	28,101	28,234	28,234
i=2001	24,820	25,457	29,286	29,825	30,665	31,678	32,099	32,456	32,597	32,751	32,751
i=2002	25,755	24,985	28,299	33,918	35,245	35,746	36,312	36,716	36,875	37,050	37,050
i=2003	13,353	18,358	22,271	27,136	28,220	28,661	29,116	29,439	29,567	29,707	29,707
i=2004	16,813	21,845	28,245	34,264	35,274	35,826	36,393	36,798	36,958	37,133	37,133
i=2005	25,985	36,637	48,140	55,945	57,594	58,494	59,421	60,082	60,343	60,628	60,628
i=2006	12,900	21,827	27,026	31,407	32,333	32,839	33,359	33,730	33,876	34,037	34,037
i=2007	11,276	16,284	20,162	23,431	24,121	24,499	24,887	25,164	25,273	25,392	25,392

Total incurred	322,508
Paid as at j=10	213,362
Reserve as at j=10	109,146

Summarizing the capital position

- Total reserve as at the end 2007:
  - Case reserve: 63,681
  - IBNR: 5,634
  - Total 69,316
- Reserve needed: 110.000
  - ➔Deficiency 40,684
  - ➔After tax 26,445

- Capital available 24,605
- Solvency I required 9,420

- Deficiency in capital: 11,260
- TECHNICALLY INSOLVENT AT ONCE

Is this a troubled portfolio?

	Premiums	Ratio on accident year		Ratio on accounting year	
		Loss	Expense	Loss	Expense
1998	26,900	72%	20%	76%	20%
1999	26,222	67%	22%	62%	22%
2000	35,209	74%	22%	77%	22%
2001	42,646	78%	22%	62%	22%
2002	48,733	74%	25%	57%	25%
2003	39,589	70%	30%	43%	30%
2004	46,504	65%	26%	58%	26%
2005	64,075	84%	26%	69%	26%
2006	53,482	76%	26%	69%	26%
2007	46,951	82%	26%	84%	26%

- High on expenses?
- Reasonably well behaving loss ratio's
- A bit late on reacting to increased losses as of 2005? (reason for premium increase?)

Agenda

- Real life example of a serious error in reserving
- The difference in Paid / Incurred
  - What to do?
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- Large claims, outliers and data errors

Data Halliwel

- Data used in case 2-4
- Estimation based on paid and incurred lead to material differences

Paid data

Cumulative paid data

	Ci1	Ci2	Ci3	Ci4	Ci5	Ci6	Ci7
i=1	266,354	432,926	465,255	518,865	526,989	543,913	583,022
i=2	246,981	606,361	835,377	904,916	1,023,551	1,123,843	
i=3	203,178	578,946	855,563	930,475	1,016,903		
i=4	395,630	656,273	823,982	1,094,674			
i=5	207,698	382,313	544,953				
i=6	167,681	447,859					
i=7	215,740						

Standard chainladder coefficients;

	Ci1-Ci2	Ci2-Ci3	Ci3-Ci4	Ci4-Ci5	Ci5-Ci6	Ci6-Ci7	Ci7-Ult
Incremental	2.087	1.327	1.157	1.091	1.076	1.072	1.000
Cumulative	4.030	1.931	1.455	1.257	1.153	1.072	1.000

Reserve 1,836,453

Incurred data

Cumulative incurred data

	Ci1	Ci2	Ci3	Ci4	Ci5	Ci6	Ci7
i=1	422,076	506,045	525,616	581,603	569,929	633,054	583,022
i=2	457,750	855,007	1,006,522	1,068,468	1,204,197	1,147,426	
i=3	345,084	727,598	1,069,667	1,081,962	1,024,044		
i=4	591,842	880,633	1,032,814	1,340,032			
i=5	379,033	536,841	611,605				
i=6	308,803	448,780					
i=7	215,851						

Standard chainladder coefficients;

	Ci1-Ci2	Ci2-Ci3	Ci3-Ci4	Ci4-Ci5	Ci5-Ci6	Ci6-Ci7	Ci7-Ult
Incremental	1.579	1.211	1.120	1.024	1.004	0.921	1.000
Cumulative	2.028	1.284	1.061	0.947	0.924	0.921	1.000

Reserve 490,668

Problems to solve

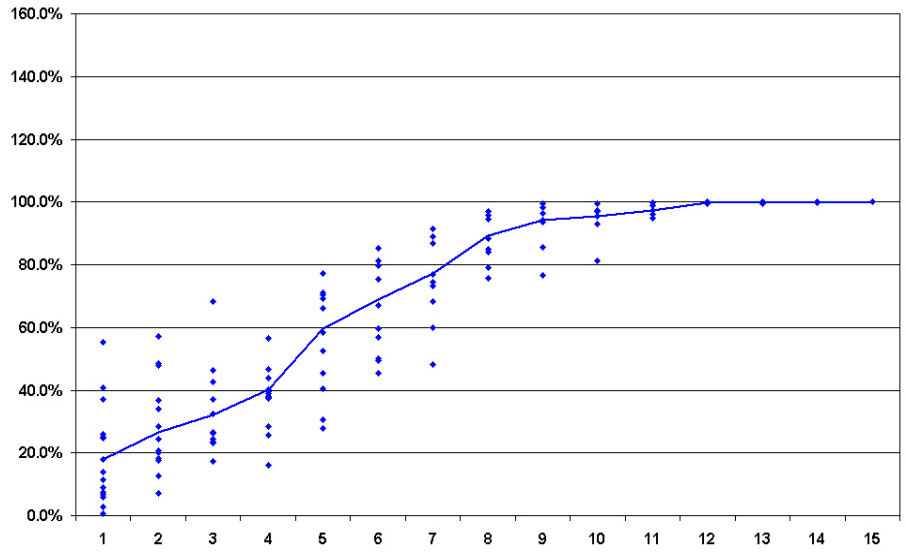
- Do you understand the data?
- Do you study the anomalies?
- Have you manually adjusted the factors?
- Have you talked to the underwriters / claim handlers?
- Do you know what to believe?
- What if there is only random difference?

Munich chainladder

- With random difference: one option is the Munich Chainladder
- There is a correlation between paid and incurred:
  - E.g. if prudently reserved:

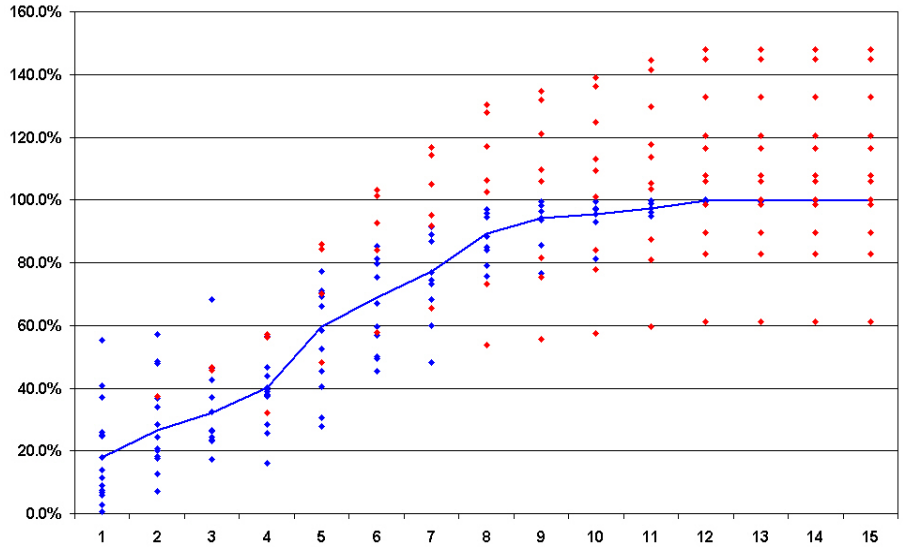
    High payments together with negative incurred factor
- Simultaneously estimation might lead to advantage: Estimate triangles Paid over Incurred

Triangle of P/I ratios vs. development years



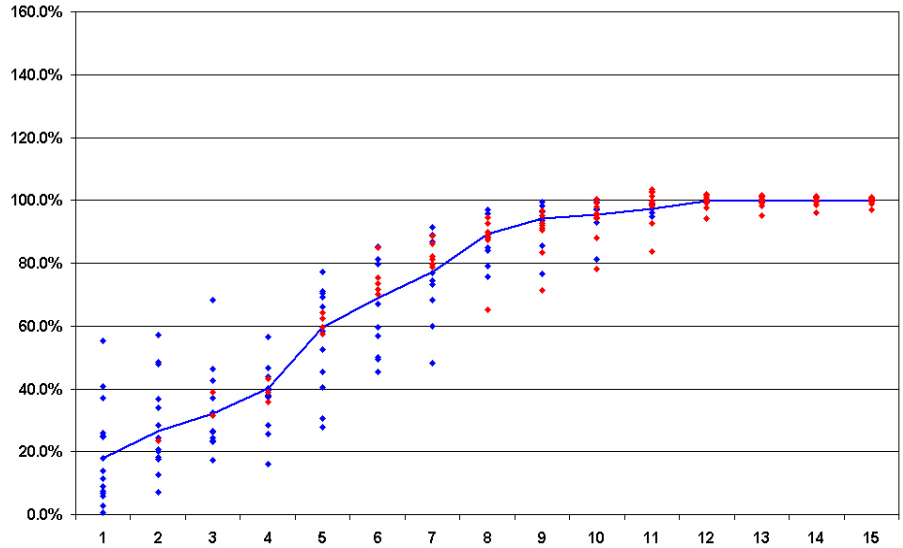
Source: G. Quarg (Munich Re Group)

P/I quadrangle (with separate Chain Ladder estimates)



Source: G. Quarg (Munich Re Group)

P/I quadrangle (with Munich Chain Ladder)



Source: G. Quarg (Munich Re Group)

Agenda

- Real life example of a serious error in reserving
- The difference in Paid / Incurred
  - What to do?
  - Munich Re Chainladder
- Large claims, outliers and data errors

Data errors

- Always start with data reconciliation
  - Reconciled data is never wrong
  - Reconciled data can be troublesome
- Missing data can lead to problems
  - E.g. only last 3 accounting years

	1	2	3	4	5	6	...
2001			25	10	5		
2002		70	30	10			
2003	105	80	25				
2004	120	90					
2005	115						

Tailfactors

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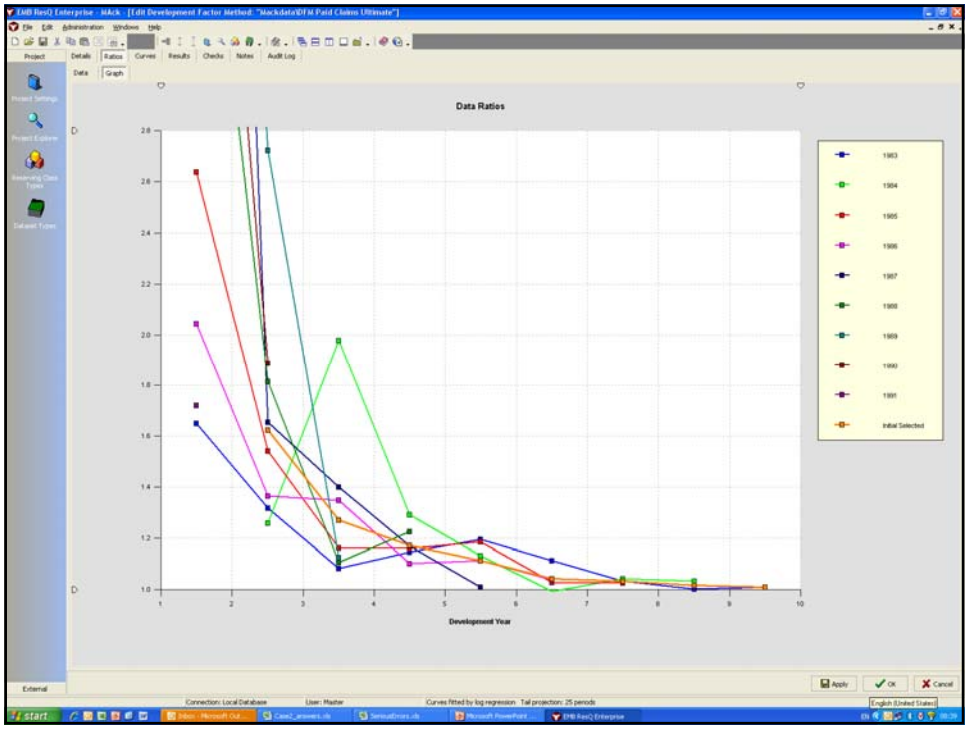
Cumulative data; Case

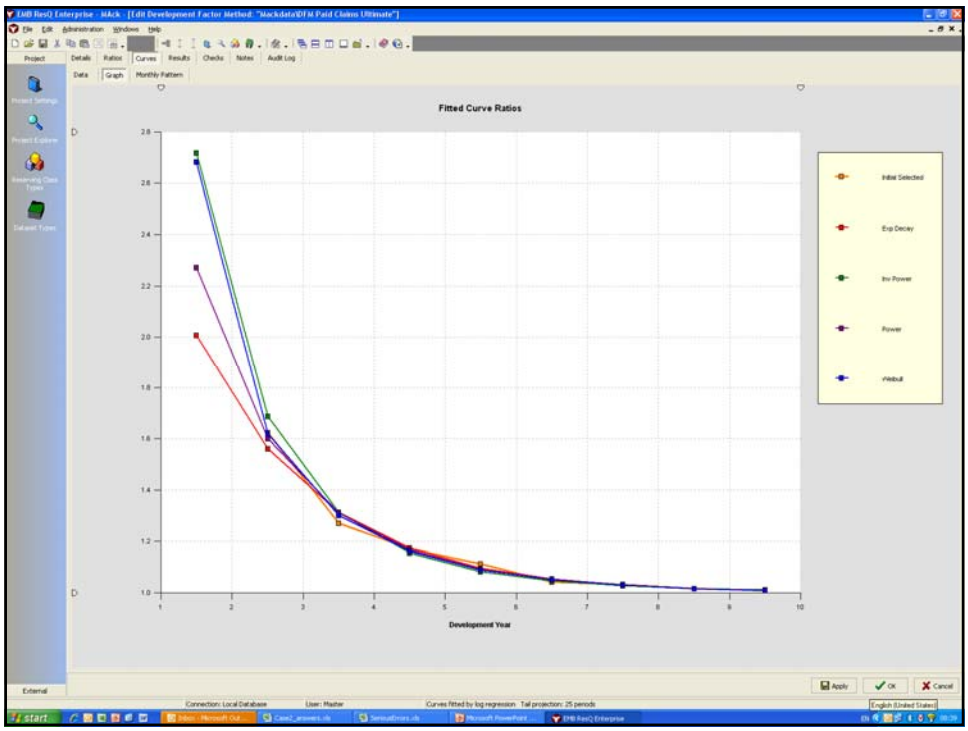
	Ci1	Ci2	Ci3	Ci4	Ci5	Ci6	Ci7	Ci8	Ci9	Ci10
i=1998	5,012	8,269	10,907	11,805	13,539	16,181	18,009	18,608	18,662	18,834
i=1999	106	4,285	5,396	10,666	13,782	15,599	15,496	16,169	16,704	
i=2000	3,410	8,992	13,873	16,141	18,735	22,214	22,863	23,466		
i=2001	5,655	11,555	15,766	21,266	23,425	26,083	27,067			
i=2002	1,092	9,565	15,836	22,169	25,955	26,180				
i=2003	1,513	6,445	11,702	12,935	15,852					
i=2004	557	4,020	10,946	12,314						
i=2005	1,351	6,947	13,112							
i=2006	3,133	5,395								
i=2007	2,063									

Standard chainladder coefficients; Case

	Ci1-Ci2	Ci2-Ci3	Ci3-Ci4	Ci4-Ci5	Ci5-Ci6	Ci6-Ci7	Ci7-Ci8	Ci8-Ci9	Ci9-Ci10	Ci10-Ult
Age-age	2.999	1.624	1.271	1.172	1.113	1.042	1.033	1.017	1.009	1.000
Multiplicative	8.920	2.974	1.832	1.441	1.230	1.105	1.060	1.026	1.009	1.000

- Tail factor seems needed





Tailfactors

- Based on quick estimations:

	Est.	R^2
– Exp Dec	1.2%	99.1%
– Inverse Power	2.7%	98.5%
– Power	1.3%	99.1%
– Weibull	1.4%	99.2%

Outliers

- What is an outlier?
  Trade off between
  - Being exact
  - Getting it right
- What to remove or manipulate (if any)
  - Actual payment / reserve?
  - Individual age-to-age factors?
  - Selected age-to-age factors?
  - Final estimate?

Large claims

- Definition (large) claim:
  - Attritional claims
  - Large claims
  - Catastrophic claims
- Truncate or remove?
- What to do with large claim itself?
  - As is (case reserve)?
  - As is multiplied by a factor?
  - Simulate from claim severity distribution
- What about IBNR large claims?
  - Simulate from claim frequency & severity distribution