Institute of Actuaries of Australia

Claim simulations and liability estimation methods

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Claim simulations and liability estimation methods

Richard Cumpston and Hugh Sarjeant

This paper has been written for the Institute of Actuaries of Australia General Insurance Seminar in Canberra, 9-12 November 2003. Richard and Hugh are directors of Cumpston Sarjeant Truslove, consulting actuaries, Melbourne.

Summary

This paper uses simulated claims to generate claim liability error distributions for five aggregate estimation methods. Error distributions are also derived for premium liability estimates. Results are given for five classes of insurance. Some conclusions are

- simulated claims can be used to choose between estimation methods, and to estimate risk margins for premium and claim liabilities
- for up to about 10,000 claims pa, risk margins decrease with increasing claim numbers, and are broadly similar for all the classes modelled
- above 10,000 claims pa, risk margins depend on external factors such as inflation and legislation.
- if the standard error of case estimates is about 1, case estimate-based methods are likely to be more reliable than other aggregate methods
- our best simulations give 75% probability estimates for compulsory third party insurance broadly similar to those of Collings & White (2001).

Background to paper

The Royal Commissioner's report on HIH (April 2003, xvii) concluded

> "The deficiency of several billion dollars has arisen because claims arising from insured events in previous years were far greater than the company had provided for."

One of the issues in the evidence to the Commission was whether actuaries should pay any regard to case estimates.

At the Institute of Actuaries of Australia Convention on 20/5/03, Geoff Atkins commented that the new role of appointed actuaries under the Insurance Act 1973 is not yet supported by adequate actuarial science. He doubted the validity of the Mack method of estimating the variance of claims estimates, and hoped that prospective estimates could be made.

A presentation on 26/5/03, by Robert Thomson and Helen Martin of APRA, discussed the estimates of risk margins and diversification benefits made by appointed actuaries. There appears to be considerable reliance on recent papers by Bateup & Reed (2001) and Collings and White (2001), both of which used the Mack method to suggest risk margins.

Early this year we were involved in two sets of litigation involving actuarial valuations of transferred claims.

Greg Taylor (2003) has suggested that actuaries are most likely to be sued over relatively small jobs.

Needs for liability estimates

Some of the needs for liability estimates in practice are

- premium-setting
- balance-sheet provisions for premium and claim liabilities
- insurer mergers, acquisitions and share market floats
- transfers of self-insured workers compensation claims
- guarantees for self-insured workers compensation claims
- reinsurance strategies
- changes to legislation.

Some liability estimation methods used in practice

Estimation method	Data used
premium basis	claim numbers and sizes
payment chain ladder	claim payments by accident and payment periods
payments per claim incurred	claim numbers reported by accident and report periods claim payments by accident and payment periods
payments per claim finalised (and payments per claim outstanding)	claim numbers reported by accident and report periods claim payments by accident and payment periods claim numbers outstanding by accident periods and estimation dates
incurred chain ladder	payments plus case estimates by accident periods and estimation dates
projected case estimates	claim payments by accident and payment periods case estimates by accident periods and estimation dates
statistical case estimates	statistical models fitted to individual claimant characteristics and payment details
case estimates	estimates based on full knowledge available on each claim

Variations of these methods found in practice include

- payment per claim incurred estimates made separately for each payment type (particularly for monopoly compensation schemes)

- projected case estimates based on the development of reported claims, with separate estimates for claims incurred but not reported
- estimates from several methods combined, taking into account the expected reliability of each method for each accident year.

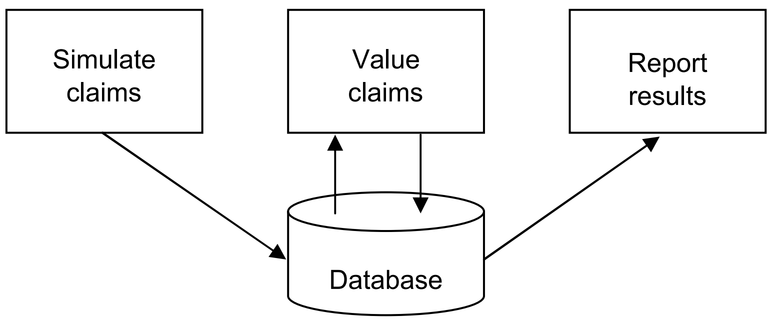
Methods using individual claims data

England & Verrall (2002, p507) commented

> "With the continuing increase in computer power, it has to be questioned whether it would not be better to examine individual claims rather than aggregated data… Models could be developed, investigating, for example, the time taken to report claims, the sizes and timings of partial payments, the delay between occurrence and reporting of claims … this allows much closer modelling of the process, including the individual case reserve amounts."

For at least a decade, it has been common Australian actuarial practice to obtain individual claims data, and to fit a variety of statistical models (Taylor 2003). But aggregate methods are still widely used, and assistance in judging their reliability may be useful. This paper uses individual claim simulations to estimate error-distributions for five commonly used aggregate methods.

Modelling process



Our modelling process is shown in the above flow-chart:

- individual claims are randomly simulated for the selected classes, and stored in a database
- successive annual valuations are made of outstanding claims, using the selected methods, and the results stored in the database
- the valuation errors are sorted by size, and 70%, 75%, 80% and 85% points reported, together with means and standard deviations.

Although using a database increased run times, it proved very useful in checking results.

Claims simulations

For each class of insurance, we randomly generated claims allowing for

- an assumed proportion of zero claims (ie claims ultimately proving to involve no payments)
- assumed claim size distributions for non-zero claims
- assumed report delay distributions for each size decile
- assumed finalisation probabilities for each size decile
- assumed case estimate distributions, as multiples of ultimate claim size
- assumed long-term variations in claim inflation
- assumed long-term variations in claim frequencies
- random year-by-year variations in claim numbers.

Classes of insurance simulated

Class	Abbre-viation	Report delay (years)	Payment delay (years)	% zero claims
Compulsory third party	CTP	0.55	3.37	20%
Domestic motor insurance	DOM	0.08	0.31	20%
Professional indemnity	PI	0.59	2.63	43%
Public liability	PL	0.52	2.67	50%
Employers liability	EL	0.16	0.49	10%

In the above table, report and payment delays are measured from the middle of the accident year. Payment delays assume no inflation.

Claim size distributions

For our basic simulations, we assumed that non-zero claims had log-normally distributed sizes, with a standard deviation of the claim sizes equal to five times their mean. Zero claims were assumed to have initial case estimates with size distributions 0.6 times those for non-zero claims.

Case estimate dispersions

For our basic simulations, we assumed that case estimates for non-zero claims, as multiples of the true cost, were log-normally distributed with mean 0.75 and standard deviation 1.5.

Report and finalisation patterns

Claims simulations require assumptions about the reporting and finalisation patterns of different sizes of claims, rather than average assumptions about all claims. These assumptions should be based on analyses of relevant individual claims data. While we had access to some specialist data, we had concerns about confidentiality and representativeness. We were also deterred by the work needed to derive reasonable assumptions.

We thus derived assumptions for five classes of insurance, intended to approximately reproduce the reporting, finalisation and payment delays evident from the last published runoff tables (Insurance and Superannuation Commission 1998). The resulting reporting and finalisation patterns are in appendix C, separately for zero claims and for each size decile of non-zero claims. We strongly recommend against the use of these patterns for any particular portfolio.

Zero claims

In practice, the proportions of zero claims depend on the nature of the business, and on office practice in establishing claim files. The above assumptions may not be realistic for many insurers. The underlying proportion of zero claims for each class was assumed to randomly vary each year in a band from 90% to 110% of the assumed proportion. In general, the higher the proportion of zero claims, the higher the risk margins, as there are fewer claims generating payments.

Years simulated

Number claims pa	Years simulated	Claims simulated
100	1000	100,000
300	300	90,000
1000	100	100,000
3000	100	300,000
10000	100	1,000,000

For simulations with 1000 or less claim pa, we felt that at least 100,000 claims needed to be simulated to give reasonably reliable variability estimates. For simulations with more than 1000 claim pa, we felt that at least 100 experience years needed to be simulated in order to get reasonably representative samples of claims inflation and long-term claim number fluctuations. In addition to the simulation years shown in the above table, an initial 10 years was used to generate initial claims outstanding.

Premium liability estimates

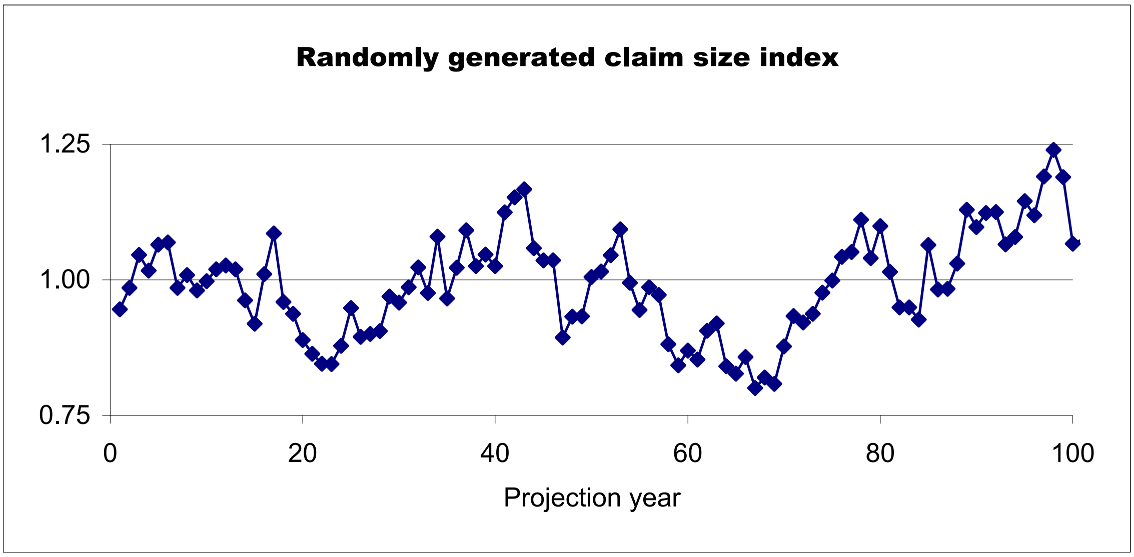
Payments per claim incurred estimates were made of premium liabilities, using exponential smoothing to estimate the number of claims likely to arise from the coming year of cover: The number of claims expected in year n was estimated as

0.2 * (number of claims in year n-1) + 0.8 * (number claims expected in year n-1)

Claim size inflation

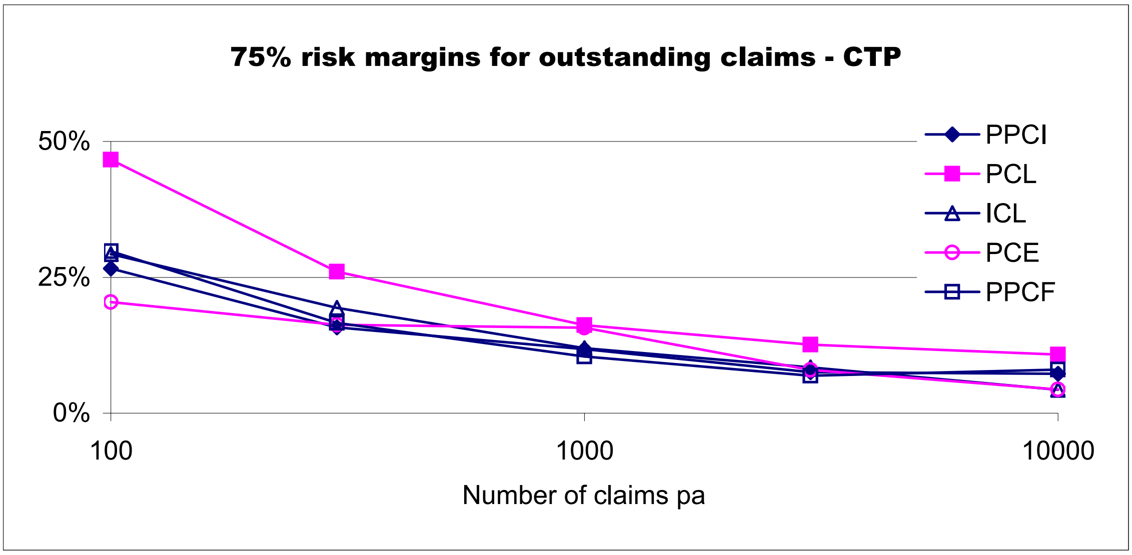
A single claim size index was randomly generated, intended to represent the combined effects of both inflation and superimposed inflation. For convenience, a claim size index was generated intended to fluctuate around a long-term value of 1. This was done by

- generating a random number for each projection year from a normal distribution with zero mean and 5% standard distribution
- calculating a size variable for the year as the generated random number plus 80% of the size variable for the preceding year
- taking the exponential of the size variable to get the claim size index (done to avoid negative values).



The above graph shows one such randomly generated claim size index for a 100 year period. Note that no autocorrelation has been assumed between successive inflation rates, although in practice several years of high inflation have occurred together, at times such as the mid 1970s.

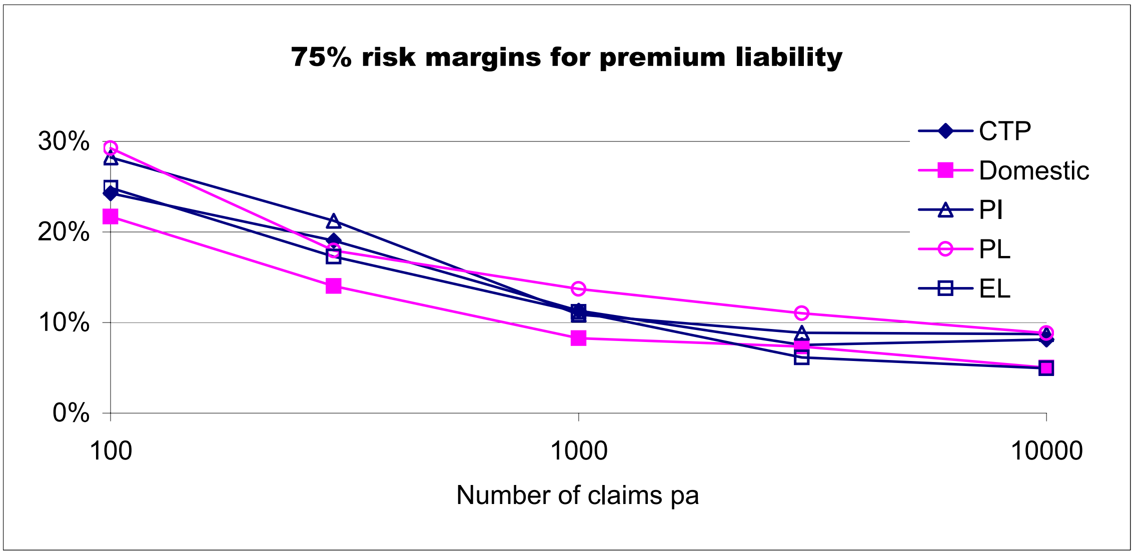
Simulations of 75% risk margins for outstanding claims



The source values for the above graph are in appendix A1. Some general conclusions from this graph, and those for the other four classes simulated (A2 to A5), are:

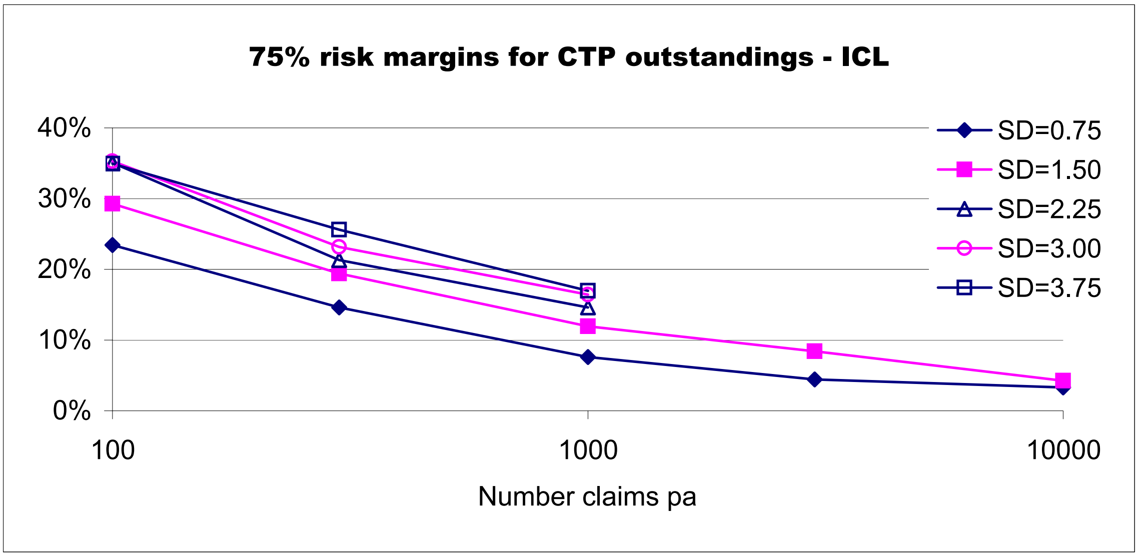
- the risk margins needed reduce as the numbers of claims pa increase
- at very high claim numbers, all methods appear to converge to a non-zero error
- payment chain ladder estimates are less reliable than those of the other four methods simulated (but this conclusion depends on the assumed reliability of case estimates).

Simulations of 75% risk margins for premium liability



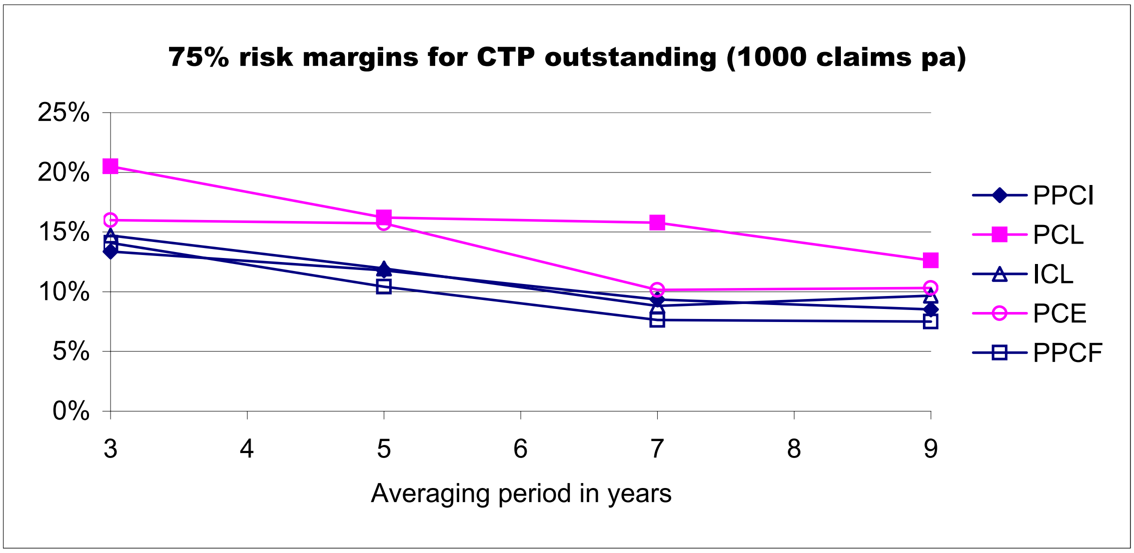
Premium liability risk margins also decrease with numbers of claims (see A6), but not to quite such low levels as outstanding claim risk margins. This is because there is uncertainty about the numbers of claims in the coming year, as well as uncertainty about the level of inflation compared with that in prior years.

Effects of case estimate variability



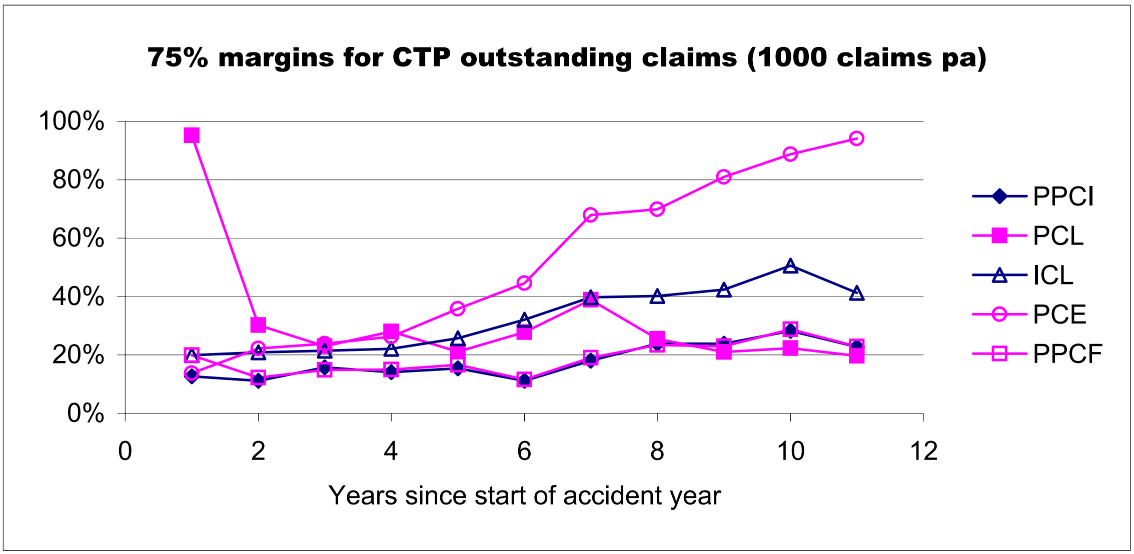
Our basic simulations were done assuming that case estimates, as a proportion of the ultimate cost of the claim, were log-normally distributed, with a mean of 0.75 and a standard deviation of 1.5. Other simulations for compulsory third party were made with a standard deviation of 0.75, 2.25, 3 and 3.75. Our results show that more accurate case estimates give significantly lower estimation errors, both for incurred chain ladder and projected case estimates (see B1 and B2).

Effects of averaging period



Longer calendar-year averaging periods reduced the estimation errors in our simulations for all methods (see B3). In practice there are always doubts about the stability of the claims environment and the office operating procedures, and a reluctance to use long averaging periods.

75% risk margins for different estimation methods

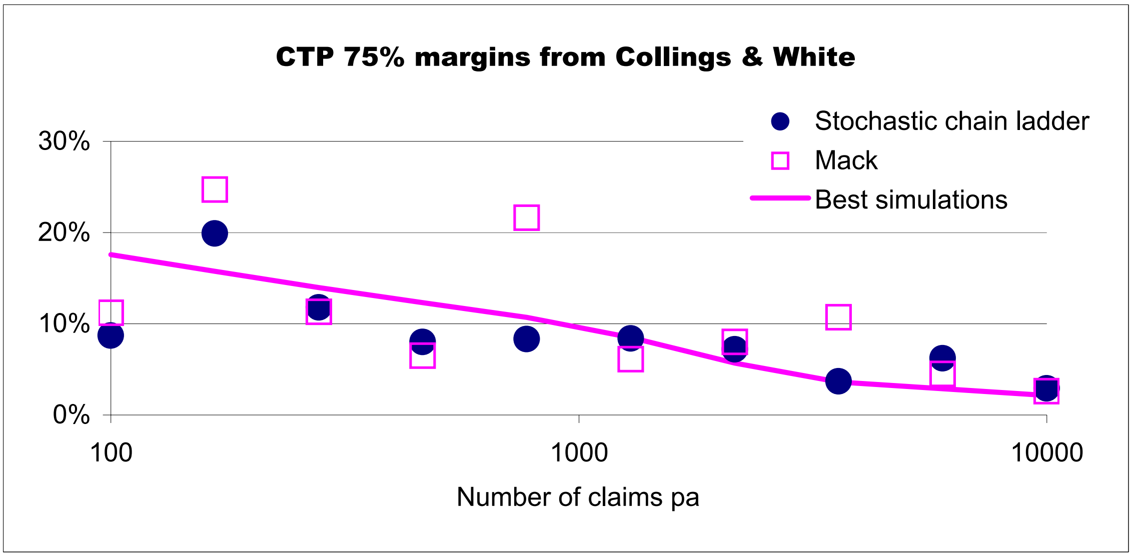


Appendix A7 gives 75% risk margins for each accident year, for a compulsory third party claims portfolio with 1000 claims pa. Payment per chain ladder estimates can be very unreliable at short durations, and this is why they are rarely used for long-tail classes. Incurred chain ladder and projected case estimates gave surprisingly poor results at long durations, and this may reflect the absence of any development year smoothing in our simulations. This needs further investigation, but it does not support the blending of payment-based methods at short durations with case-estimate based methods at long durations.

Comparing 75% margins with 50% of the standard error

Throughout this paper we have shown 75% probability levels, as these proved to be more stable than standard errors. Our detailed outputs showed that the 75% levels were nearly always greater than 50% of the standard error (APRA's alternative capital requirement). Our incurred chain ladder and projected case estimate simulations did however sometimes generate very high outliers, giving large standard errors. We suspect these outliers resulted from our lack of development year smoothing at old durations, but need to investigate this further.

Comparisons with Collings & White 75% CTP margins



The above graph compares the 75% percentile results in Collings & White (2001, appendix A) with our best simulations for CTP. Collings & White only rank their insurers by size, and we have arbitrarily assumed the smallest insurer had 100 claims pa and the largest 10000, with an even spacing between. Our best simulations used projected case estimates, and assumed that the standard deviation of case estimates, as multiples of the actual outcomes, was 0.75. Our best simulations are broadly similar to those of Collings and White (see A8).

Limitations of work to date

Some of the limitations of our work are

- report delays, finalization probabilities, claim size distributions and case estimate errors are all broad assumptions, rather than being based on specific portfolios
- all claims are assumed to be paid in one amount (a particularly poor assumption for employers liability)
- the case estimate for each claim is assumed to be constant until it is settled
- no distinction is made between inflation and superimposed inflation, and their combined long-term rate is assumed to be zero
- no allowance is made for discounting
- no allowance is made for correlation between classes (needed if estimates are to be made of diversification benefits).
- the allowances for inflation and superimposed inflation may understate the

large costs and savings sometimes resulting from legislative changes

- no simulations have yet been made of the effects of excess reinsurance.

Further work

We hope that further work will be done on many of the issues that we have left unexplored or unresolved. We would be happy to collaborate in any such work.

Acknowledgements

We are grateful for the help given to us by Greg Taylor, personally and through his book "Loss reserving - an actuarial perspective" (2000). Adrian Gould and Bob Buchanan provided helpful data on claim size distributions. Scott Collings and Graham White's excellent 2001 paper provided some valuable data to check our results. We are also grateful to Paul Cassidy and David Service, for letting us test some of the ideas in this paper on their general insurance and control cycle students.

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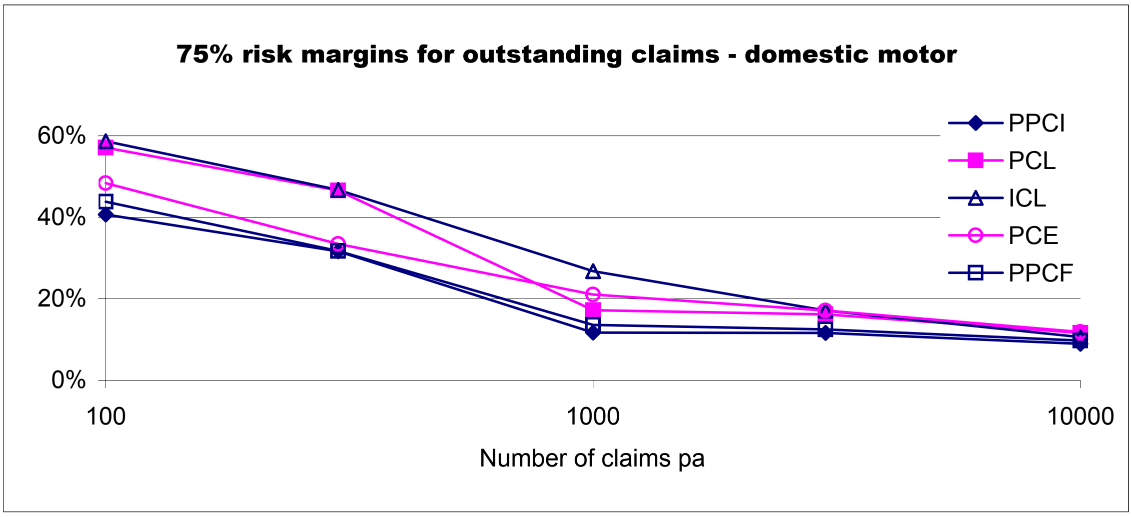
Appendix A : Basic simulations

A1 75% risk margins for outstanding claims - CTP

Method	Claims pa				
	100	300	1000	3000	10000
PPCI	27%	16%	12%	8%	7%
PCL	47%	26%	16%	13%	11%
ICL	29%	19%	12%	8%	4%
PCE	20%	16%	16%	8%	4%
PPCF	30%	17%	10%	7%	8%

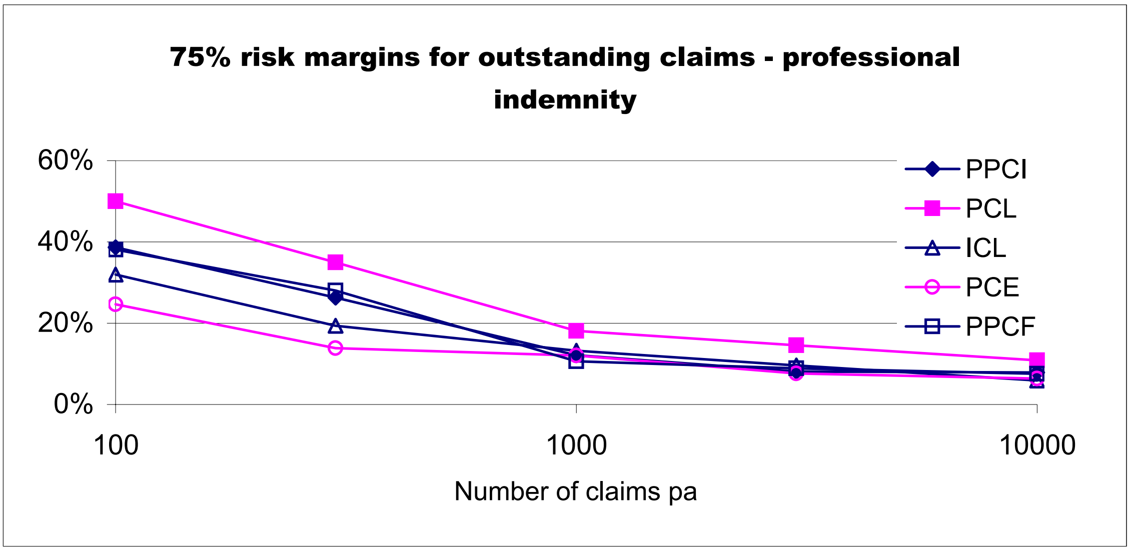
A2 75% risk margins for outstanding claims - domestic motor

Method	Claims pa				
	100	300	1000	3000	10000
PPCI	41%	32%	12%	12%	9%
PCL	57%	47%	17%	16%	12%
ICL	59%	47%	27%	17%	11%
PCE	48%	33%	21%	17%	12%
PPCF	44%	32%	14%	12%	10%



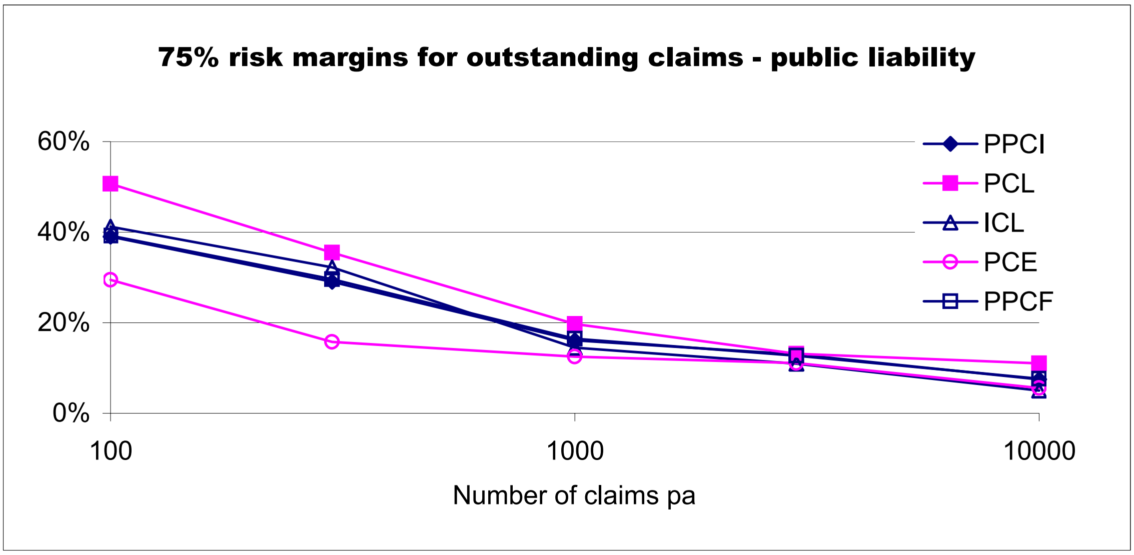
A3 75% risk margins for outstanding claims - prof indemnity

Method	Claims pa				
	100	300	1000	3000	10000
PPCI	39%	26%	12%	8%	8%
PCL	50%	35%	18%	15%	11%
ICL	32%	19%	13%	10%	6%
PCE	25%	14%	12%	8%	6%
PPCF	38%	28%	11%	9%	8%



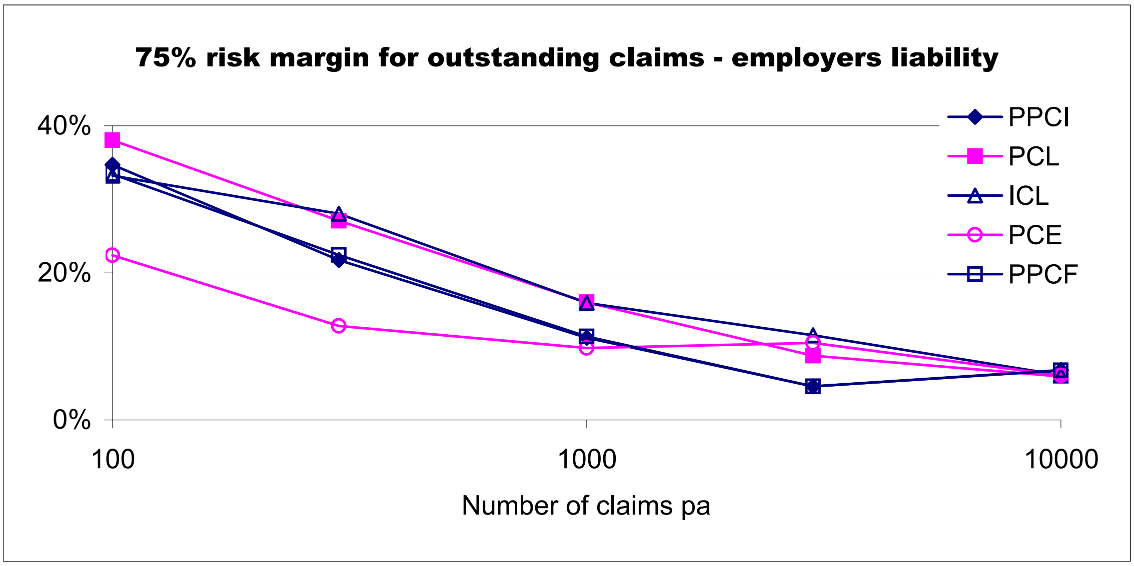
A4 75% risk margins for outstanding claims - public liability

Method	Claims pa				
	100	300	1000	3000	10000
PPCI	39%	29%	16%	13%	7%
PCL	51%	35%	20%	13%	11%
ICL	41%	32%	14%	11%	5%
PCE	29%	16%	13%	11%	6%
PPCF	39%	30%	17%	13%	8%



A5 75% risk margins for outstanding claims - employers liability

Method	Claims pa				
	100	300	1000	3000	10000
PPCI	35%	22%	11%	5%	7%
PCL	38%	27%	16%	9%	6%
ICL	33%	28%	16%	12%	6%
PCE	22%	13%	10%	10%	6%
PPCF	33%	22%	11%	5%	7%



A6 75% risk margins for premium liability

Class	Claims pa				
	100	300	1000	3000	10000
CTP	24%	19%	11%	8%	8%
Domestic	22%	14%	8%	7%	5%
PI	28%	21%	11%	9%	9%
PL	29%	18%	14%	11%	9%
EL	25%	17%	11%	6%	5%

A7 75% risk margins for outstanding claims - CTP 1000 claims pa

Accident	75% risk margins for outstanding claims				
year	PPCI	PCL	ICL	PCE	PPCF
	PPCI	PCL	ICL	PCE	PPCF
1	12.7%	95.2%	19.9%	13.8%	20.0%
2	11.2%	30.2%	20.9%	22.3%	12.3%
3	15.8%	23.0%	21.5%	23.8%	14.9%
4	14.1%	28.1%	22.2%	26.3%	15.0%
5	15.4%	21.2%	25.7%	35.8%	16.7%
6	11.1%	27.9%	32.1%	44.6%	11.6%
7	18.0%	38.9%	39.7%	67.9%	19.1%
8	23.8%	25.5%	40.2%	69.9%	23.4%
9	23.9%	21.1%	42.4%	80.9%	23.0%
10	28.3%	22.4%	50.6%	88.7%	28.8%
11	22.8%	19.7%	41.2%	94.1%	22.9%
Total	11.8%	16.2%	11.9%	15.7%	10.4%

A8 Comparison with Collings & White CTP 75% percentiles

Claims pa	SCL	Mack	Best simulations
	SCL	Mack	Best simulations
100	8.7%	11.2%	17.6%
167	19.9%	24.7%	15.8%
278	11.8%	11.3%	13.9%
464	8.0%	6.5%	12.3%
774	8.3%	21.6%	10.7%
1292	8.4%	6.1%	8.5%
2154	7.2%	8.0%	5.7%
3594	3.7%	10.7%	3.6%
5995	6.2%	4.5%	2.9%
10000	2.9%	2.6%	2.2%

The stochastic chain ladder and Mack values are from Collings & White (2001, appendix A). The best simulations are interpolated from the PCE results in B2 with a standard error of 0.75.

Appendix B : Variations to basic simulations

B1 75% risk margins for outstandings - CTP with ICL method

Standard deviation of case estimate adequacy	Claims pa 100	300	1000	3000	10000
SD=0.75	23%	15%	8%	4%	3%
SD=1.50	29%	19%	12%	8%	4%
SD=2.25	35%	21%	15%		
SD=3.00	35%	23%	16%		
SD=3.75	35%	26%	17%		

B2 75% risk margins for outstandings - CTP with PCE method

Standard error of case estimate adequacy	Claims pa 100	300	1000	3000	10000
SD=0.75	18%	14%	10%	4%	2%
SD=1.50	20%	16%	16%	8%	4%
SD=2.25	19%	20%	14%		
SD=3.00	17%	20%	14%		
SD=3.75	16%	20%	14%		

B3 75% risk margins for outstandings - CTP 1000 claims

Method	Averaging period in years 3	5	7	9
PPCI	13%	12%	9%	9%
PCL	20%	16%	16%	13%
ICL	15%	12%	9%	10%
PCE	16%	16%	10%	10%
PPCF	14%	10%	8%	7%

Appendix C : Class assumptions

Report patterns - CTP

Size	Proportion of claims reported in the following development years										
decile	0	1	2	3	4	5	6	7	8	9	10+
0	0.667	0.230	0.052	0.028	0.009	0.003	0.003	0.002	0.001	0.001	0.003
1	0.782	0.214	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.777	0.217	0.003	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
3	0.769	0.221	0.005	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
4	0.758	0.225	0.009	0.005	0.002	0.001	0.001	0.000	0.000	0.000	0.001
5	0.742	0.228	0.015	0.008	0.003	0.001	0.001	0.001	0.000	0.000	0.001
6	0.718	0.232	0.025	0.014	0.004	0.001	0.002	0.001	0.000	0.000	0.002
7	0.679	0.235	0.043	0.024	0.008	0.003	0.003	0.002	0.001	0.001	0.003
8	0.614	0.239	0.074	0.041	0.013	0.004	0.005	0.003	0.001	0.001	0.005
9	0.506	0.243	0.127	0.069	0.022	0.007	0.008	0.005	0.002	0.002	0.008
10	0.323	0.247	0.217	0.118	0.038	0.013	0.013	0.009	0.004	0.004	0.014
Mean	0.667	0.230	0.052	0.028	0.009	0.003	0.003	0.002	0.001	0.001	0.003

Finalisation probabilities - CTP

Size	Probability of finalisation in the following development years										
decile	0	1	2	3	4	5	6	7	8	9	10+
0	0.049	0.371	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
1	0.049	0.371	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
2	0.049	0.371	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
3	0.049	0.371	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
4	0.049	0.371	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
5	0.049	0.371	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
6	0.049	0.371	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
7	0.056	0.308	0.576	0.576	0.576	0.576	0.576	0.576	0.576	0.576	0.576
8	0.063	0.245	0.451	0.451	0.451	0.451	0.451	0.451	0.451	0.451	0.451
9	0.070	0.182	0.327	0.327	0.327	0.327	0.327	0.327	0.327	0.327	0.327
10	0.078	0.119	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203

The above assumptions were chosen so as to approximately replicate the CTP data for states other than NSW in table 6.2 of "Selected statistics on the general insurance industry for year ended 30 June 1997" (Insurance and Superannuation Commission 1988).

"Size decile 0" was used to describe the behaviour of claims ultimately proving to be zero. Size deciles 1 to 10 describe claims ultimately proving to be non-zero.

Report patterns - DOM

Size decile	Proportion of claims reported in the following development years 0	1	2	3	4	5	6	7	8	9	10+
0	0.932	0.064	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.871	0.118	0.007	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
2	0.891	0.101	0.005	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
3	0.908	0.086	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
4	0.923	0.073	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.935	0.063	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.945	0.053	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.953	0.046	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.960	0.039	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.966	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.971	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean	0.932	0.064	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Finalisation probabilities - DOM

Size decile	Proportion of finalisation in the following development years 0	1	2	3	4	5	6	7	8	9	10+
0	0.720	0.906	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
1	0.720	0.906	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
2	0.720	0.906	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
3	0.720	0.906	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
4	0.720	0.906	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
5	0.720	0.906	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
6	0.720	0.906	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
7	0.750	0.860	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450
8	0.780	0.814	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
9	0.810	0.767	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
10	0.840	0.721	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900

The above assumptions were chosen so as to approximately replicate the domestic motor vehicle data in table 6.4 of "Selected statistics on the general insurance industry for year ended 30 June 1997" (Insurance and Superannuation Commission 1988).

Report patterns - PI

Size decile	0	1	2	3	4	5	6	7	8	9	10+
	Proportion of claims reported in the following development years										
0	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
1	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
2	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
3	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
4	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
5	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
6	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
7	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
8	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
9	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
10	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002
Mean	0.642	0.255	0.057	0.018	0.007	0.006	0.007	0.005	0.002	0.001	0.002

Finalisation probabilities - PI

Size decile	0	1	2	3	4	5	6	7	8	9	10+
	Proportion of finalisation in the following development years										
0	0.102	0.612	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
1	0.102	0.612	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
2	0.102	0.612	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
3	0.102	0.612	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
4	0.102	0.612	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
5	0.102	0.612	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
6	0.102	0.612	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
7	0.115	0.474	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730
8	0.129	0.335	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561
9	0.142	0.197	0.391	0.391	0.391	0.391	0.391	0.391	0.391	0.391	0.391
10	0.155	0.058	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222

The above assumptions were chosen so as to approximately replicate the professional indemnity data in table 6.5 of "Selected statistics on the general insurance industry for year ended 30 June 1997" (Insurance and Superannuation Commission 1988).

Report patterns - PL

Size decile	Proportion of claims reported in the following development years 0	1	2	3	4	5	6	7	8	9	10+
0	0.720	0.202	0.030	0.018	0.008	0.004	0.004	0.002	0.001	0.001	0.009
1	0.810	0.188	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.805	0.191	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001
3	0.799	0.194	0.003	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.001
4	0.790	0.197	0.005	0.003	0.001	0.001	0.001	0.000	0.000	0.000	0.002
5	0.778	0.200	0.009	0.005	0.002	0.001	0.001	0.001	0.000	0.000	0.003
6	0.759	0.203	0.015	0.009	0.004	0.002	0.002	0.001	0.000	0.000	0.005
7	0.729	0.207	0.025	0.015	0.006	0.003	0.004	0.002	0.001	0.001	0.008
8	0.679	0.210	0.043	0.026	0.011	0.006	0.006	0.003	0.001	0.001	0.013
9	0.597	0.213	0.074	0.045	0.019	0.010	0.010	0.005	0.002	0.002	0.023
10	0.459	0.217	0.126	0.076	0.032	0.017	0.018	0.009	0.004	0.003	0.039
Mean	0.720	0.202	0.030	0.018	0.008	0.004	0.004	0.002	0.001	0.001	0.009

Finalisation probabilities - PL

Size decile	Proportion of finalisation in the following development years 0	1	2	3	4	5	6	7	8	9	10+
0	0.594	0.720	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
1	0.594	0.720	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
2	0.594	0.720	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
3	0.594	0.720	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
4	0.594	0.720	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
5	0.594	0.720	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
6	0.594	0.720	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
7	0.467	0.580	0.582	0.582	0.582	0.582	0.582	0.582	0.582	0.582	0.582
8	0.341	0.439	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464
9	0.214	0.299	0.346	0.346	0.346	0.346	0.346	0.346	0.346	0.346	0.346
10	0.087	0.158	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228

The above assumptions were chosen so as to approximately replicate the public liability data in table 6.7 of "Selected statistics on the general insurance industry for year ended 30 June 1997" (Insurance and Superannuation Commission 1988).

Report patterns - EL

Size	Proportion of claims reported in the following development years										
decile	0	1	2	3	4	5	6	7	8	9	10+
0	0.879	0.103	0.010	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.001
1	0.927	0.062	0.006	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000
2	0.919	0.069	0.007	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000
3	0.910	0.076	0.008	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000
4	0.900	0.084	0.008	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000
5	0.890	0.093	0.009	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.001
6	0.878	0.104	0.010	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.001
7	0.865	0.115	0.012	0.003	0.002	0.001	0.001	0.000	0.001	0.000	0.001
8	0.850	0.127	0.013	0.004	0.002	0.001	0.001	0.001	0.001	0.000	0.001
9	0.834	0.141	0.014	0.004	0.002	0.001	0.001	0.001	0.001	0.000	0.001
10	0.816	0.156	0.016	0.004	0.003	0.001	0.001	0.001	0.001	0.000	0.001
Mean	0.879	0.103	0.010	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.001

Finalisation probabilities - EL

Size	Proportion of finalisation in the following development years										
decile	0	1	2	3	4	5	6	7	8	9	10+
0	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
1	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
2	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
3	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
4	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
5	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
6	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
7	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
8	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
9	0.697	0.990	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
10	0.111	0.212	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283

The above assumptions were chosen so as to approximately replicate the employers liability data for Western Australia in table 6.11 of "Selected statistics on the general insurance industry for year ended 30 June 1997" (Insurance and Superannuation Commission 1988).