AMERICAN ACADEMY *of* ACTUARIES

**Report on Modeling of Principles-Based Reserves for 20-year Level Premium Term Insurance
from the American Academy of Actuaries' Life Reserves Work Group**

**Presented to the National Association of Insurance Commissioners'
Life and Health Actuarial Task Force**

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Background

In late 2005, the LRWG illustrated the results of applying the principles-based approach (PBA) to reserving for 20-year level premium term insurance. While the illustrated reserves under PBA were generally lower than current formulaic reserves, concerns were expressed because the early duration reserves under the PBA were higher than current formulaic reserves.

Upon review, the issue turns on the level of margin included in each reserving assumption under the PBA, and the way those margins affect the reserve. Under the current formulaic net premium approach, the effect of reserve margins is dampened in early durations because any margin that increases the present value of benefits also increases the present value of net premiums. Under the PBA, the effect of reserve margins is not dampened in this way because gross premiums replace net premiums in the calculation, and gross premiums do not change with reserving assumptions. So any margin in reserving assumptions increases the reserve in early durations to a greater degree under PBA than under the current formulaic approach.

In our initial illustrations of 20-year term we used margins for mortality based on those built into the 2001 CSO table, along with margins for interest, lapse, and expense. In our view, the aggregate margin is much higher than is appropriate under the PBA. Under the PBA, for example, valuation assumptions are revised periodically rather than being locked in at issue. Also, the PBA margins are specific to each company and thus these margins need not allow for the variation of experience among a wide range of companies (as is the case for margins under the formula-based approach.) This follow-up report illustrates the effect of different levels of margins.

Some changes were made to the 20-year term insurance policy used in our prior illustrations. For simplicity, the option to renew past 20 years has been removed; the policy terminates at the end of 20 years. Coincident with that change we have adjusted the premium rates, raising them slightly to reflect the absence of any possibility of profit in the "tail" period past 20 years. The resulting premium rates are still competitive, as shown later.

A change in assumptions was also made since our prior illustrations. We are now assuming that the company's mortality experience is fully credible, so there is no need to blend to an industry table. In the previous illustration an additional margin was added in the process of blending to the industry table. Since the focus this time around is on margins, we didn't want to cloud the issue by including such blending in the illustration. All margins are now explicit deviations from best estimates.

Details of the premium rates and other assumptions are attached, along with a summary of reserve results using five different levels of margin.
- Level 1: Deterministic interest scenario, 2001 CSO mortality margins, 30% lower lapse rates
- Level 2: Same as level 1, but mortality margin of 9.375 deaths per 1000 divided by e_x
- Level 3: Same as level 1, but mortality margin of 3.5 deaths per 1000 divided by e_x
- Level 4: Deterministic interest scenario, mortality margin of 3.2%, no other margins
- Level 5: Deterministic interest scenario, mortality margins of 2.1%, 10% lower lapse rates

Observations on the results

- The reserve at the end of the first year is much lower than the "initial" reserve just before issue. This decline is due to the payment of acquisition expenses, thereby significantly reducing the present value of future expenses that must be included in the reserve. In many cases the decline pushes the calculated reserve below zero, so the cash value floor comes into play.

- The level of margins consistent with an "initial" reserve of zero is smaller than we may be used to. The illustrated level 4 and level 5 margins are at this level in the aggregate. For policies that are expected to produce a reasonable profit, margins at this level would be most consistent with the market price for risk, because they equate the present value of benefits and expenses with the present value of premiums.

- In our previous illustrations, the stochastic reserve for a sample inforce block exceeded the deterministic reserve. Using level 4 margins the zero seriatim floor comes into play in more cases for the deterministic reserve, so the deterministic reserve is about equal to the stochastic reserve.

Quantifying margins using Z

One tool to measure the relative size of the aggregate margin included in the reserves is a number we are calling "Z", which is defined as follows:

$$Z = (\text{Reserve held} - \text{Best Estimate liability}) / (\text{present value of capital requirement})$$

Z represents the amount by which the pre-tax return on capital is expected to exceed the return on invested assets. Given this connection with the return on capital, it provides an indication of whether margins are within a reasonable range.

Values of Z are shown for the various levels of margins, both at time of issue and at the end of the 10th policy year. For purposes of these illustrations, we set the level of capital to 100% of claims plus 5% of the reserve. This is meant to be illustrative of the level of capital actually held, not necessarily minimum regulatory capital. It can be seen that level 4 and level 5 margins are associated with Z values around 4%. This is consistent with the pricing IRR on distributable earnings of 10%, or about 4% in excess of the investment return. Margins at levels 1 to 3 are associated with much higher values of Z. Under level 1 margins, which are those used in our earlier illustrations, Z is 90.7% for issue age 45.

Here are some further observations on the levels of Z shown in these illustrations:

- With current formulaic reserves, Z starts small at issue, then gets very large by duration 10. This reflects the non-intuitive way mortality margins affect current formulaic reserves. Mortality margins increase not only the present value of benefits but also the net premiums. In early durations the present value of higher net premiums (higher due to the margin) largely offsets the increase in value of future benefits. At later durations there are fewer premiums left to collect and this offset is reduced, more fully exposing the margin in the present value of benefits. This results in a hump-backed pattern of margins in the reserve. This hump-backed pattern does not exist for principles-based reserves, as illustrated by the fact that Z does not change much between issue and duration 10.

- Margins at levels 4 and 5 are both consistent with a release-from risk framework, where margins are set so that the present value of premiums equals the present value of benefits and expenses at time of issue. Levels 4 and 5 differ in the source of margin. Level 4 includes a larger mortality margin than level 5, but level 5 includes a margin in persistency assumptions while level 4 does not. The difference in the source of margin leads to small differences in the level and pattern of Z values by duration.

A deterministic margin in the discount rate is used in all the principles-based calculations, and requires some explanation. The discount rate is the projected yield on the asset portfolio, based on a model simulation of bond maturities and re-investment. Future re-investment takes place at the market interest rates assumed in a scenario, so the projected portfolio rates depend on the assumed scenario of future interest rates. Our illustrated Best Estimate scenario assumes interest rates will rise a bit over time. The deterministic scenario assumes interest rates move to a lower level (to be stipulated by regulation) over time. As a result, the projected portfolio rates under the deterministic scenario are lower than our best estimate, and the difference starts small and increases over time as the starting portfolio runs off and is re-invested.

Product description and pricing: issue age 45

Plan of insurance:	20-year level term insurance No renewal option after 20 years
Insured life:	Male age 45 best class nonsmoker

Annual premium rate per $1000:	$1.35
Policy fee:	$65
Total premium for $1,000,000 policy:	$1,415.00
Pre-tax IRR on distributable earninings:	10%

Market perspective: issue age 45

Annual premiums for similar $1,000,000 policy

Company	Premium
Company 1	$ 1,200
Company 2	$ 1,240
Company 3	$ 1,240
Company 4	$ 1,250
Company 5	$ 1,270
Company 6	$ 1,280
Company 7	$ 1,280
Company 8	$ 1,290
Company 9	$ 1,309
Company 10	$ 1,310
Company 11	$ 1,310
Company 12	$ 1,315
Company 13	$ 1,330
Company 14	$ 1,330
Company 15	$ 1,335
Company 16	$ 1,345
Company 17	$ 1,370
Company 18	$ 1,380
Company 19	$ 1,390
Company 20	$ 1,390
Company 21	$ 1,400
Company 22	$ 1,405
Company 23	$ 1,410
LRWG modeled premium	$ 1,415
Company 24	$ 1,420
Company 25	$ 1,430
Company 26	$ 1,435
Company 27	$ 1,470
Company 28	$ 1,500
Company 29	$ 1,525
Company 30	$ 1,535
Company 31	$ 1,540
Company 32	$ 1,550
Company 33	$ 1,550
Company 34	$ 1,600
Company 35	$ 1,645
Company 36	$ 1,716
Company 37	$ 1,755
Company 38	$ 1,785

Product description and pricing: issue age 65

Plan of insurance:	20-year level term insurance
	No renewal option after 20 years
Insured life:	Male age 65 best class nonsmoker

Annual premium rate per $1000:	$11.81
Policy fee:	$65
Total premium for $1,000,000 policy:	$11,875
Pre-tax IRR on distributable earninngs:	10%

Market perspective: issue age 65
Annual premiums for similar $1,000,000 policy

Company	Premium
Company 1	$ 9,980
Company 2	$ 10,000
Company 3	$ 10,010
Company 4	$ 10,100
Company 5	$ 10,180
Company 6	$ 10,265
Company 7	$ 10,480
Company 8	$ 10,570
Company 9	$ 10,640
Company 10	$ 10,655
Company 11	$ 11,080
Company 12	$ 11,100
Company 13	$ 11,415
Company 14	$ 11,430
Company 15	$ 11,830
LRWG modeled premium:	$ 11,875
Company 16	$ 12,050
Company 17	$ 12,255
Company 18	$ 12,270
Company 19	$ 12,375
Company 20	$ 12,380
Company 21	$ 12,510
Company 22	$ 12,765
Company 23	$ 13,150
Company 24	$ 13,575
Company 25	$ 13,750
Company 26	$ 17,940

Valuation assumptions: issue age 45

attained age	Mortality rates				Withdrawal rates		
	Best Estimate per 1000	with margin of 9.375 / ex per 1000	with margin of 3.5 / ex per 1000	with 2001 CSO margin	Best Estimate	with 10% margin	with 30% margin
45	0.1969	0.4794	0.2983	0.6369	7.0%	6.30%	4.90%
46	0.2885	0.5798	0.3931	0.7598	7.5%	6.75%	5.25%
47	0.3720	0.6725	0.4798	0.8769	6.5%	5.85%	4.55%
48	0.4396	0.7500	0.5510	0.9809	6.5%	5.85%	4.55%
49	0.4973	0.8181	0.6124	1.0779	6.0%	5.40%	4.20%
50	0.6758	1.0078	0.7950	1.2991	6.0%	5.40%	4.20%
51	0.7479	1.0918	0.8713	1.4174	6.0%	5.40%	4.20%
52	0.8245	1.1813	0.9526	1.5443	5.0%	4.50%	3.50%
53	0.9149	1.2855	1.0479	1.6893	5.0%	4.50%	3.50%
54	1.0594	1.4448	1.1977	1.8936	5.0%	4.50%	3.50%
55	1.1870	1.5886	1.3312	2.0865	5.0%	4.50%	3.50%
56	1.4160	1.8351	1.5665	2.3872	5.0%	4.50%	3.50%
57	1.6548	2.0928	1.8121	2.7047	5.0%	4.50%	3.50%
58	1.9255	2.3842	2.0902	3.0621	5.0%	4.50%	3.50%
59	2.1679	2.6492	2.3407	3.4003	5.0%	4.50%	3.50%
60	2.4653	2.9714	2.6470	3.8042	5.0%	4.50%	3.50%
61	2.7473	3.2810	2.9389	4.2049	5.0%	4.50%	3.50%
62	3.0925	3.6567	3.2951	4.6832	5.0%	4.50%	3.50%
63	3.4610	4.0593	3.6757	5.2015	5.5%	4.95%	3.85%
64	3.8769	4.5137	4.1055	5.7874	100.0%	100.00%	100.00%

year	Investment yields (discount rates)	
	Best Estimate	Padded
1	5.95%	5.95%
2	5.83%	5.82%
3	5.73%	5.70%
4	5.65%	5.59%
5	5.58%	5.48%
6	5.52%	5.38%
7	5.46%	5.27%
8	5.40%	5.17%
9	5.35%	5.05%
10	5.28%	4.92%
11	5.37%	4.91%
12	5.48%	4.92%
13	5.59%	4.93%
14	5.70%	4.93%
15	5.80%	4.94%
16	5.90%	4.94%
17	5.99%	4.95%
18	6.08%	4.95%
19	6.18%	4.95%
20	6.30%	4.96%

Expense Assumptions		
	Best Estimate	Padded 5%
Non Acquisition		
Per Policy	$40.00	$42.00
% of Prem	0%	0%
Per Unit	$0.00	$0.00
Per Death	$100.00	$105.00
Per Surrender	$20.00	$21.00
Prem Taxes	2.50%	2.625%
Acquisition		
Per Policy	$ 73.74	$ 73.74
% of Prem	10.0%	10.0%
Per Unit	$ 1.29	$ 1.29
First yr commission	130%	130%
Commission chgback		
lapse in months 1-6	100%	100%
lapse in months 7-13	50%	50%

Valuation assumptions: issue age 65

	Mortality rates				Withdrawal rates		
attained age	Best Estimate per 1000	with margin of 9.375 / ex per 1000	with margin of 3.5 / ex per 1000	with 2001 CSO margin	Best Estimate	with 10% margin	with 30% margin
45	1.3760	1.8250	1.5372	2.7649	7.0%	6.3%	4.9%
46	2.5175	2.9884	2.6865	4.0188	7.5%	6.8%	5.3%
47	3.4571	3.9516	3.6347	5.0813	6.5%	5.9%	4.6%
48	4.3561	4.8762	4.5428	6.1155	5.5%	5.0%	3.9%
49	4.8387	5.3868	5.0354	6.7475	5.0%	4.5%	3.5%
50	5.7851	6.3643	5.9931	7.8610	5.0%	4.5%	3.5%
51	6.5024	7.1159	6.7226	8.7646	5.0%	4.5%	3.5%
52	8.0143	8.6663	8.2484	10.4866	4.0%	3.6%	2.8%
53	9.0866	9.7812	9.3359	11.7948	4.5%	4.1%	3.2%
54	10.9813	11.7242	11.2480	13.9581	5.0%	4.5%	3.5%
55	12.2725	13.0697	12.5587	15.5547	3.0%	2.7%	2.0%
56	14.6577	15.5173	14.9663	18.2929	3.0%	2.7%	2.0%
57	16.0865	17.0176	16.4207	20.1299	3.0%	2.7%	2.0%
58	19.2619	20.2772	19.6264	23.7880	3.0%	2.7%	2.0%
59	21.4584	22.5725	21.8583	26.5551	3.0%	2.7%	2.0%
60	25.6765	26.9101	26.1193	31.4664	3.0%	2.7%	2.0%
61	28.3852	29.7640	28.8801	35.0220	3.0%	2.7%	2.0%
62	34.0294	35.5924	34.5905	41.7437	3.0%	2.7%	2.0%
63	37.7128	39.5123	38.3587	46.8175	3.0%	2.7%	2.0%
64	44.6971	46.8212	45.4596	55.7099	100.0%	100.0%	100.0%

	Investment yields (discount rates)	
year	Best Estimate	Padded
1	5.95%	5.95%
2	5.83%	5.82%
3	5.73%	5.70%
4	5.65%	5.59%
5	5.58%	5.48%
6	5.52%	5.38%
7	5.46%	5.27%
8	5.40%	5.17%
9	5.35%	5.05%
10	5.28%	4.92%
11	5.37%	4.91%
12	5.48%	4.92%
13	5.59%	4.93%
14	5.70%	4.93%
15	5.80%	4.94%
16	5.90%	4.94%
17	5.99%	4.95%
18	6.08%	4.95%
19	6.18%	4.95%
20	6.30%	4.96%

Expense Assumptions	Best Estimate	Padded 5%
Non Acquisition		
Per Policy	$40.00	$42.00
% of Prem	0%	0%
Per Unit	$0.00	$0.00
Per Death	$100.00	$105.00
Per Surrender	$20.00	$21.00
Prem Taxes	2.50%	2.625%
Acquisition		
Per Policy	$ 73.74	$ 73.74
% of Prem	10.0%	10.0%
Per Unit	$ 1.29	$ 1.29
First yr commission	130%	130%
Commission chgback		
lapse in months 1-6	100%	100%
lapse in months 7-13	50%	50%

Terminal reserves per policy

$1,000,000 20-yr level premium term
Select Male Issue Age 45
Annual premium $1,415.00
Note: Negative values in this table would be floored at zero

Policy Year-end	Current Formulaic	Principles-based with margins					PBA Best Estimate
		Level 1	Level 2	Level 3	Level 4	Level 5	
Pre-issue	-	6,931	3,309	1,249	3	2	(362)
1	-	4,785	947	(1,143)	(2,448)	(2,436)	(2,834)
2	3,386	5,956	1,888	(239)	(1,618)	(1,588)	(2,026)
3	6,673	7,081	2,813	667	(760)	(717)	(1,184)
4	9,859	8,214	3,752	1,591	130	181	(309)
5	12,892	9,328	4,699	2,536	1,063	1,118	611
6	15,737	10,323	5,541	3,383	1,909	1,966	1,449
7	18,309	11,295	6,379	4,234	2,778	2,832	2,310
8	20,578	12,147	7,158	5,049	3,630	3,679	3,159
9	22,525	12,931	7,903	5,842	4,477	4,519	4,005
10	24,145	13,583	8,554	6,554	5,263	5,292	4,791
11	25,289	14,102	9,123	7,199	5,999	6,014	5,530
12	25,769	14,368	9,494	7,664	6,570	6,569	6,110
13	25,655	14,337	9,638	7,921	6,949	6,929	6,503
14	24,996	13,939	9,496	7,916	7,076	7,040	6,655
15	23,686	13,156	9,068	7,653	6,956	6,905	6,567
16	21,467	11,880	8,265	7,045	6,498	6,436	6,153
17	18,151	10,062	7,062	6,075	5,680	5,614	5,392
18	13,566	7,562	5,347	4,635	4,388	4,327	4,173
19	7,566	4,279	3,046	2,660	2,550	2,509	2,430
20	-						

Reserve Margins (assuming floor of zero)

The margins shown below are the excess of the terminal reserve from above over the PBA best estimate from above

Policy Year-end	Current Formulaic	Principles-based with margins					PBA Best Estimate
		Level 1	Level 2	Level 3	Level 4	Level 5	
Pre-issue	362	7,293	3,671	1,611	364	364	-
1	2,834	7,619	3,782	2,834	2,834	2,834	-
2	5,412	7,982	3,914	2,026	2,026	2,026	-
3	7,858	8,266	3,997	1,851	1,184	1,184	-
4	10,169	8,523	4,061	1,900	439	491	-
5	12,281	8,717	4,088	1,925	452	507	-
6	14,288	8,874	4,092	1,934	460	517	-
7	15,998	8,985	4,069	1,923	468	522	-
8	17,419	8,988	3,999	1,889	470	520	-
9	18,519	8,926	3,897	1,836	472	513	-
10	19,354	8,791	3,763	1,763	471	501	-
11	19,759	8,572	3,593	1,669	469	484	-
12	19,660	8,258	3,384	1,554	461	459	-
13	19,152	7,834	3,134	1,418	446	426	-
14	18,341	7,284	2,841	1,262	422	386	-
15	17,120	6,589	2,501	1,086	390	338	-
16	15,314	5,727	2,112	893	346	283	-
17	12,759	4,670	1,670	683	288	222	-
18	9,392	3,389	1,173	462	214	154	-
19	5,135	1,848	616	230	120	79	-
20	-						

Interest rate margin:		Deterministic.	Deterministic.	Deterministic.	Deterministic.	Deterministic.	None
Mortality margin:		2001CSO	.009375/ex	.0035/ex	3.2%	2.1%	None
Lapse rate margin		30%	30%	30%	None	10%	None

Z							
At issue	4.50%	90.7%	45.7%	20.0%	4.5%	4.5%	0.0%
At 10 yrs	228.40%	103.70%	44.40%	20.80%	5.60%	5.90%	0.00%

$1,000,000 20-yr level premium term
Select Male Issue Age 65
Annual premium $11875.00
Note: Negative values in this table would be floored at zero

| Policy Year-end	Current Formulaic	Principles-based with margins					PBA Best Estimate
		Level 1	Level 2	Level 3	Level 4	Level 5	
Pre-issue	-	25,916	7,717	3,849	(73)	346	(3,966)
1	-	18,732	(438)	(4,422)	(8,631)	(8,144)	(12,734)
2	22,483	29,126	8,862	4,741	187	758	(4,129)
3	44,193	39,322	18,067	13,833	9,082	9,694	4,614
4	65,059	49,208	27,094	22,777	17,942	18,562	13,382
5	85,058	59,255	36,375	31,993	27,192	27,784	22,566
6	104,198	69,203	45,574	41,134	36,490	37,013	31,805
7	122,540	79,279	54,939	50,448	46,110	46,514	41,365
8	140,105	88,082	63,247	58,746	54,694	54,993	49,951
9	156,842	96,861	71,525	67,013	63,444	63,570	58,679
10	171,494	104,894	79,045	74,521	71,648	71,526	66,854
11	183,540	110,593	84,762	80,316	77,913	77,664	73,191
12	192,291	114,342	88,714	84,376	82,471	82,093	77,864
13	196,843	116,816	91,665	87,479	86,132	85,616	81,661
14	195,922	116,167	91,822	87,837	87,038	86,399	82,774
15	187,852	112,903	89,834	86,121	85,876	85,127	81,877
16	172,506	104,631	83,448	80,096	80,313	79,502	76,709
17	148,714	91,998	73,584	70,721	71,319	70,499	68,223
18	114,672	71,148	56,729	54,528	55,265	54,550	52,910
19	66,889	42,382	33,782	32,494	33,110	32,635	31,726
20	-	-	-	-	-	-	-

Reserve Margins (assuming floor of zero)

The margins shown below are the excess of the terminal reserve from above over the PBA best estimate from above

Policy Year-end	Current Formulaic	Principles-based with margins					PBA Best Estimate
		Level 1	Level 2	Level 3	Level 4	Level 5	
Pre-issue	3,966	29,882	11,683	7,814	3,966	4,311	-
1	12,734	31,466	12,734	12,734	12,734	12,734	-
2	26,613	33,255	12,991	8,870	4,316	4,888	-
3	39,580	34,709	13,453	9,220	4,469	5,081	-
4	51,677	35,826	13,712	9,395	4,560	5,180	-
5	62,492	36,689	13,809	9,428	4,627	5,218	-
6	72,393	37,398	13,769	9,329	4,684	5,207	-
7	81,175	37,914	13,574	9,083	4,745	5,149	-
8	90,155	38,131	13,296	8,795	4,743	5,043	-
9	98,164	38,182	12,846	8,335	4,765	4,892	-
10	104,641	38,040	12,192	7,667	4,794	4,672	-
11	110,349	37,401	11,571	7,125	4,721	4,472	-
12	114,427	36,478	10,850	6,512	4,607	4,229	-
13	115,183	35,155	10,005	5,818	4,472	3,956	-
14	113,148	33,394	9,048	5,063	4,264	3,625	-
15	105,975	31,025	7,956	4,243	3,999	3,249	-
16	95,797	27,923	6,739	3,387	3,604	2,793	-
17	80,491	23,775	5,361	2,498	3,096	2,277	-
18	61,762	18,239	3,820	1,619	2,356	1,641	-
19	35,163	10,656	2,056	768	1,385	909	-
20	-	-	-	-	-	-	-
Interest rate margin:		Deterministic.	Deterministic.	Deterministic.	Deterministic.	Deterministic.	None
Mortality margin:		2001CSO	.009375/ex	.0035/ex	3.2%	2.1%	None
Lapse rate margin		30%	30%	30%	None	10%	None
Z							
At issue	4.50%	34.1%	13.3%	8.9%	4.5%	4.9%	0.0%
At 10 yrs	113.00%	41.10%	13.20%	8.30%	5.20%	5.00%	

Reserves per policy, issue age 45

Reserves per policy, issue age 65
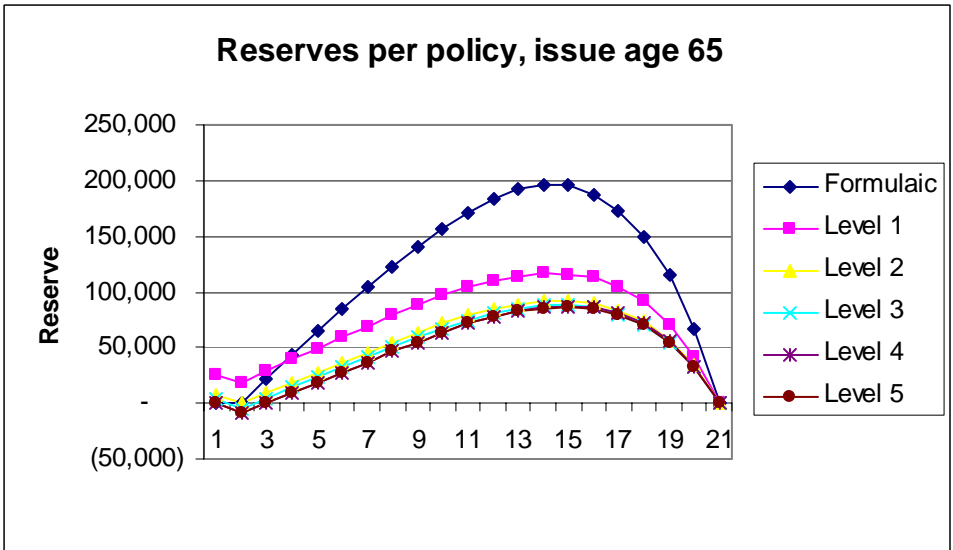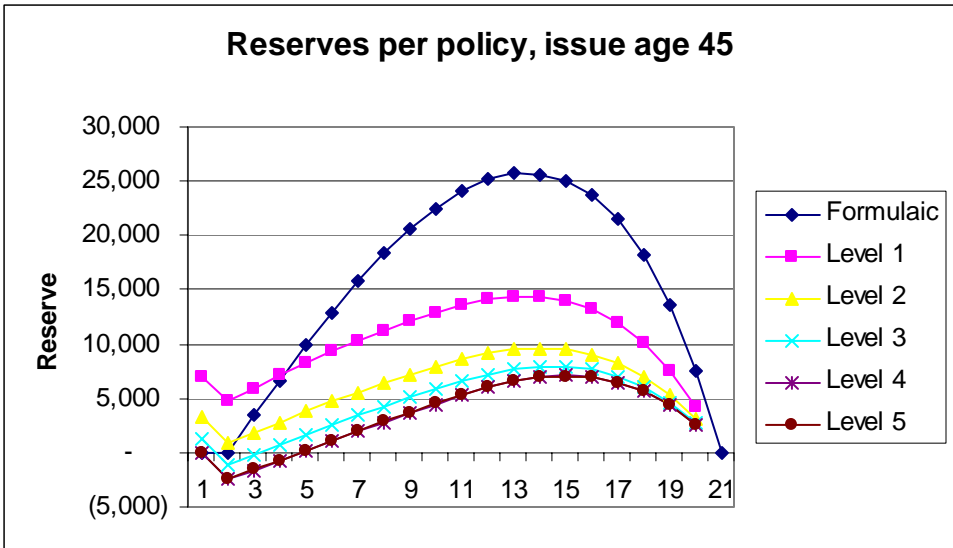
The chart below shows the distribution of the stochastic reserve for our simulated inforce block. The 65 CTE level is $41.1 million, virtually the same as the seriatim deterministic reserve.
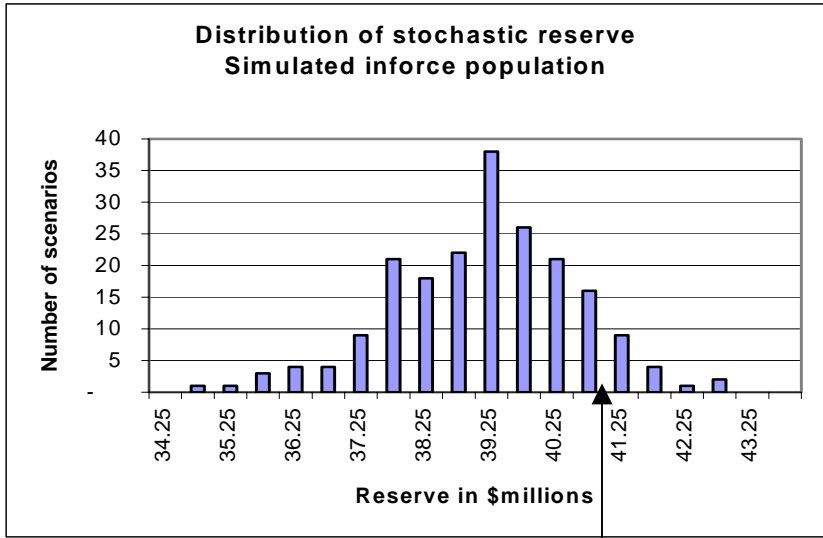
Deterministic reserve level

APPENDIX 1

Below is the list of names of the companies used in the market perspective. Some companies offer several products at different prices. Also, some of the companies are cited in both at issue age 45 and issue age 65:

Allianz	
American General	Midland National
American National	Minnesota
Ameritas	North American
AmerUs	Northwestern Mutual
AxaEquitable	Pacific
Banner	Phoenix
Chase	Physicians Life
Empire	Protective
FGLife	Prudential
First Colony	ReliaStar
Genworth Life	Symetra
Golden Rule	Transamerica
Hartford Life	Travelers
Jackson National	Union Central
Jefferson Pilot	United of Omaha
John Hancock	USFinancial
Lincoln	Vantis
MetLife	West Coast