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PRL1 - 2 : Assignment 2

Unit 3 & 4

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709

Q1. A company might wish to carry out sensivity analysis as a part of its profit testing exercise in order to understand the impact of changes in factors that might affect profit. These factors include interest rates, mortality assumptions, risk discount rates, etc.

If the basis used for profit testing are varied, the resulting profit will differ and the company will know how robust their figures are.

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Q3.

i. Profit vector is the vector of balancing items in the project revenue accounts for each policy year is called the profit vector. It gives the expected profit at the end of each year per policy in force at the beginning of that policy year.

ii. The objective specified for expected level of profit is termed as profit criterion.

Eg: NPV = 40% of initial sales commision

Profit margin = 5% of EPV of premium income

iii. risk discount rate = risk free rate + margin for risk

= 10% + 3%

= 13%

$EPV \text{ of profit}_{(13\%)} = 250v + 150v^2 + 200v^3 + 225v^4$

$= 172.84$

let first year's premium be P

$\therefore$ EPV of premium = $P(1 + 1.04 p_{42} v + 1.04^2 {}_2p_{42} v^2 + 1.04^3 {}_3p_{42} v^3)$

$= 3.541186 P$

$\therefore$ Profit margin = 5% $= \frac{172.84}{3.541186 P}$

$\therefore P = 976.17.$

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Q4.

i. Experience basis, Pricing basis and valuation (reserving) basis are the different basis used in financial management

ii. While the student actuary is correct that reserves are held such that there is an acceptable low probability of insolvency occuring in the future, its incorrect to assume that everyone will die on the day after the valuation date. This is because:

- the reserving basis chosen has to satisfy any local legislation and professional guidance which exists to protect the interest of the policyholder.

iii. Profit vector: $\left(-20, \frac{-35.20}{1p_{[70]}}, \frac{50}{2p_{[70]}}, \frac{-28.5}{3p_{[70]}}, \frac{-20}{4p_{[70]}}, \frac{90.21}{5p_{[70]}}\right)$

$= (-20, -35.79, 52.12, -30.65, -22.27, 104.40)$

$4V = \frac{22.27}{1.06} = 21.01$

$3V = \frac{(30.65 + 21.01 p_{73})}{1.06} = 48.06$

$\therefore$ Profit $= 52.12 - 48.06 p_{72}$

$= 5.54$

$1V = \frac{35.79}{1.06} = 33.76$

Profit $= -20 - 33.76\, {}_1p_{[70]} = -53.20$

$\therefore$ revised profit vector $= (-53.20, 0, 5.54, 0, 0, 104.40)$

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Q5.

i. Unit fund represents the value of unit of the policyholder at any time.

It doesn't necessarily represent the amount the policy holder is entitled to at any point.

On death, maturity or surrender, the units held will be used to pay the benefits.

Non-unit funds arise from:

- Premium less cost of allocation
- expenses incurred by the insurer
- interest earned on non-unit fund
- tMC
- cost of outgoes, if outgoes > unit fund value
- profit on surrender

ii. The life company sets up non unit reserves if the overall cashflow in any month except month one is negative without reserves. The policy would be self financing in the future after month 1.

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Q4.

i.

Year	Age	Profit vector	q_x	p_x	$l_{(x+1)}$	Profit signature
1	30	-250	0.00059	0.99941	1	-250
2	31	-400	0.000602	0.999398	0.99941	-379.76
3	32	-600	0.000617	0.999383	0.998196	-599.29
4	33	1500	0.000634	0.999366	0.997192	1497.24

Present Value

-235.83

-355.79

-503.17

1185.99

NPV @6% = 91.18

ii. $_2V = \frac{600}{1.03} = 582.52$

$_1V = (400 + 582.52 \times 0.99941)/1.03 = 953.37$

year 1 CF : $-250 - 953.37 \times 0.99941$

$\therefore = -1203$

$\therefore$ NPV $= -1203/1.06 + 1185.99$

$= 51.08$

iii. The NPV after zeroising cashflows to achieve a single financing phase is smaller. This is because the negative cashflows have been accelerated hence discounted less

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Q7.

i.

Age	Ind. prob death	Ind. prob surr	dep prob surr	dep prob mort
61	0.006433	0.06	0.0598	0.00624
62	0.009696	0.06	0.05971	0.00941
63	0.011344	0.06	0.05966	0.01
64	0.012716	0.06	0.05962	0.01233

Prob of survive at end	Prob. surv at start
0.99395	1
0.93089	0.99395
0.92934	0.86940
0.92805	0.80797

unit fund :

year	Premium	fund at the start	Alloc. prem. (less) bid/off.	Policy fee
1	30000		12000 − 600	−
2	30000	11790	27000 − 1350	−
3	30000	38723	30000 − 1500	−
4	30000	69525	33000 − 1650	−

fund before interest	interest	fund after interest.	FMC	fund at the end
114180	570	114750	− 180	11790
37440	1872	39312	− 590	38723
67223	3361.14	70584	− 1059	69525
105875	5043.76	105919	− 1589	104330

non-unit fund :

unalloc. prem	bid/offer	policy fee	commision	expenses
18000	+ 600	−	− 6000	− 5000
3000	+ 1350	−	− 600	− 2000
−	+ 1500	−	− 600	− 2000
(3000)	+ 1650	−	− 600	− 2000

fund before interest	(add)int	maturity benefit	EMC	death benefit
7600	266	-	+180	550.43
1750	61.25		+550	576.32
(1100)	(38.50)		+1059	335.34
(3950)	(138.25)	4841.16	+1589	-

non-unit cf

7495.12

1824.62

-415.03

-7340.63

PV of Profit = 7004.79 + 1448.43 − 294.58 − 4524.73

= 3673.91

PV of Premium = 98753.01

∴ Profit margin = 3.72 %

ii. higher or lower depending on surrender benefit.

iii. To cover high initial expenses

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Q8. $P\ddot{a}_{[60]:4} = 500{,}000\ A_{[60]:4} + (100 + 0.025P) \times (\ddot{a}_{[60]:4} - 1) + 800$

Solving:

$P = \frac{429343}{3.662}$

$P = 117{,}250$

year	Prem	expense	opening reserve	int	death claim
1	117250.76	800	0	5822.53	3216.5
2	117250.76	3031.27	116200	11520.97	4848
3	117250.76	3031.27	237910	17606.479	5672
4	117250.76	3031.27	365665	23994.224	6358.00

Surrender claim	maturity claim	closing reserve	profit
3825.02		109,679.87	3352.12
11612.52		223,821.92	1658.04
17387.12		343442.08	3234.78
-	493642		3878.72

NPV of profit signature = 9288.71

NPV of premium = 386,618.04

Profit margin = 2.40%.

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Q9.

x	$(aq)_x^d$	$(aq)_x^d$	$(ap)_x$	$\wedge_{-42}(ap)_x$
42	0.000922	0.099903	0.899170	1
43	0.001150	0.099885	0.898965	0.89917
44	0.001327	0	0.998673	0.808323

Calc unit fund:

year	unit fund at start	Alloc. prem	bid/off.	interest
1	0	3000	75	268.25
2	3148.40	8000	200	985.36
3	11784.59	9250	231.25	1872.30

AMC	Unit fund at the end
39.85	3148.4
149.17	11784.59
983.45	22392.19

year	unalloc. prem	bid/off	expenses	commission	interest
1	7000	75	2000	1000	282.25
2	2000	200	750	300	80.50
3	750	231.25	750	350	-4.81

AMC	death cost	maturity cost	EF	Prob. in force
39.85	15.54	0	4384.56	1
149.17	9.45	0	1370.22	0.899170
283.45	0	3354.37	-3144.48	0.808323

disc. factor	EPV of profit	EPV Prem.	EPV of Prem	Profit margin
0.884956		1000		
0.783147	3083.46	8991.70	24,287.61	12.70%
0.693056		8083.23		

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Q10. unit fund

Policy year	Prem	cost alloc	W/d	Fund before charge
1	17500	15750	15750	16852.5
2	27500	24750	41018.24	43859.92
3	27500	24750	67920.07	72619.47
4	27500	24750	96561.10	103320.38

Fund management charge	Policy admin fees	Fund c/fd
84.26	500	18268.24
219.45	500	43170.07
363.37	500	71811.10
516.60	500	102303.78

Policy year	Profit on alloc	expenses	non unit death cost	Profit
1	9250	3150	730.98	6085.78
2	250	1100	321.45	-517.50
3	250	1100	0	-46.13
4	250	1100	0	101.10