

PRLI-2 Assignment - 2
Atharva Padwal
Roll No. 703.

Q1. Sensitivity analysis determines how different values of an independent variable affect a particular dependent variable.

In profit testing, sensitivity analysis could help ~~us~~ us understand the impact on profit earned from factors like risk discount rate, bid offer spread, ~~a~~ interest rate, expenses and commissions, etc.

Q2. Doubt.

Q3. PTO

Q3

~~Q4~~

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

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

iii) Risk discount rate = risk free rate + margin for risk
= 13%.

$$\begin{aligned} EPV_{\text{profit}} &= -250V + 150V^2 + 200V^3 + 225V^4 \\ &= 172.84 \end{aligned}$$

Let first year premium be P

$$\begin{aligned} EPV_{\text{premium}} &= P[1 + 1.04^1 p_{42}V + 1.04^2 2p_{42}V^2 \\ &\quad + 1.04^3 3p_{42}V^3] \\ &= 3.541186 P \end{aligned}$$

$$\begin{aligned} \text{Profit Margin} &= \frac{EPV_{\text{profit}}}{EPV_{\text{premium}}} \\ P &= 976.17 \end{aligned}$$

Q4.

- i. Experience basis is used to calculate the expected future profits of a contract for comparison with a stated profit criterion. It represents the best estimate of expected future experience.

Pricing basis is used while setting premium. Assuming the risk discount rate reflects fully the uncertainties in the assumptions, the pricing basis represents the insurer's realistic expected outlook.

Valuation basis is used to calculate

- 5 = the reserves to be held by an ~~ins~~ insurer.

- ii) where the student actuary is correct that reserves are held such that there is an acceptably low possibility of insolvency, it is incorrect to assume that everyone will die on the day after valuation date. This is because:-

- A company whose reserving basis is extremely pessimistic ~~will~~ will be holding extremely high reserves leading to large capital requirement. This will require higher profits resulting in higher premiums/charges for customer.

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

iii. Profit vector =

$$= \left[-20, \frac{-35-20}{1P_{70}}, \frac{50}{2P_{70}}, \frac{-28.5}{3P_{70}}, \frac{-20}{4P_{70}}, \frac{104-40}{5P_{70}} \right]$$

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

Let reserves required at the end of policy year n be denoted as nV .

$$5V = 0$$

$$4V = \frac{22.27}{1.06} = 21.01 \quad ; \text{ Profit in year 5} = 0$$

$$3V = \frac{(30.65 + 21.01 / P_{73})}{1.02} = 48.06$$

$$\text{Profit in year 4} = 0$$

$$2V = 0$$

$$\text{Profit in year 3} = 52.12 - 48.06 / P_{72} = 5.54$$

$$1V = \frac{35.79}{1.01} = 33.76$$

$$\text{Profit in year 2} = 0$$

$$\text{Revised profit in year 1} = -20 - 33.76 / P_{70} = -53.20$$

$$\text{Revised Profit vector} = [-53.20, 0, 5.54, 0, 0, 104.40]$$

85

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

It ~~de~~ does not necessarily represent the amount that the Policyholder will get the S.V. which is the proportion of unit fund.

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

Non-unit fund will arise from the following sources:-

- a) Premium less cost of allocation i.e. the difference between the premium paid and amount invested in the fund.
- b) Expenses incurred by the ~~investor~~ insurer
- c) Interest earned on non-unit fund.
- d) FMC taken from unit fund.
- e) Cost of outgoes if outgo amount is greater than the value of units.
- f) Profit on surrender.

ii) ~~The~~ The life company if the ~~sets~~ sets up non-unit reserves if the overall cash flow in any month other than month one is negative without reserves. The

Policy should be ^{self} financing after month one.

Reserves are set up early so that money can be ~~released~~ released as and when required to eliminate the negative cashflow. Setting up reserves will result in delay of profits but gives the comfort to the company that capital is sufficient to support the policy throughout the term.

Q6.

i)	Year	Age	Profit Vector	q_1	q_2	P_{t-1}	Profit Signature	Present Value
	1	20	-250	0.00059	0.99941	1	(250)	(235.85)
	2	31	-400	0.000602	0.999398	0.99941	(399.76)	(355.79)
	3	32	-600	0.000617	0.999383	0.999809	(599.29)	(503.11)
	4	33	1600	0.000636	0.999364	0.999172	1497.29	1185.91

$$NPV = 91.18$$

$$ii) \quad 2V = \frac{600}{1.03} = 582.85$$

$$1V = \frac{400 + (582.85 \times 0.99941)}{1.03} = 153.57$$

$$\text{Year 1 revised cashflow} = -250 - 153.57 \times 0.99941 = -1203$$

$$NPV = \frac{-1203}{1.03} + 1185.91 = 51.08$$

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

Q7 Decrement table

Age	Independent prob-death	Independent prob-surv	Dependent prob-surv	Dep prob mort
61	0.006433	0.01	0.05981	0.00624
62	0.009696	0.06	0.05971	0.00941
63	0.011344	0.06	0.05966	0.01100
64	0.012716	0.06	0.05962	0.01233

Prob surv at
end

0.93395

0.93089

0.92934

0.92805

Prob survival
at start

1.0

0.93395

0.86940

0.80797

~~Unit Fund~~

Year	1	2	3
Premium	30000	30000	30000
Fund at start	—	11790	—

Unit Fund

Year	1	2	3	4
Premium	30000	30000	30000	30000
Fund at start	—	11790	38723	69525
Allocated Prem	12000	27000	30000	53000
Less Bro offer spread	600	1350	1500	1650
Policy fee	—	—	—	—
Fund before interest	14400	37440	67223	100875
Plus Interest	570	1872	3861.14	5043.76
Fund after interest	11970	39312	70584	105919
Less FMC	180	590	1059	1589

Fundal end 11790 38723 69525 104330

Non unit fund

Unallocated Prem	18000	30000	—	3000
Add Bid offer spread	600	1350	1500	1650
Policy fee	—	—	—	—
Less commis	6000	600	600	600
Less exp	5000	2000	2000	2000
Fund before int	7000	1750	(1100)	(3900)
Add int	266	61.25	(38.50)	(138.25)
Less Maturity ben	—	—	—	4644.14
FMC	180	590	1059	1589
Less additional ren	580.43	576.32	335.34	—
Non unit cashflow	7459.12	1824.62	(415.08)	(7340.63)

Profit margin

Profit	7459.12	1824.62	(415.08)	(7340.63)
Prob surv.	1	0.93395	0.81940	0.8079
Disc. factor - profit	0.93457	0.82343	0.81629	0.762895
PV profit	7004.79	1488.43	(294.58)	(4524.71)

Dis factor prem

PV prem.	30000	261856	22781.12	19280
----------	-------	--------	----------	-------

Profit margin = 3.72%

- ii. Profit margin could be higher or lower depending on the definition of the surrender benefits. If a sizeable surrender penalty is imposed such that the unit fund mostly covers the surrender benefit, profit margins could improve.
- iii) To cover high initial expenses.

Q8

$$P \ddot{a}_{61:4} = 500000 A_{61:4} + (100 + 0.25P)(\ddot{a}_{61:4} - 1) + 800$$

$$P(0.975 \times 3.736 + 0.025) = 500000 A \approx 0.85654 + 100 \times 2.730 + 500$$

$$P = 117260$$

$$1V = 1 - \frac{\ddot{a}_{62:3}}{\ddot{a}_{61:4}} = 0.23240$$

$$2V = 1 - \frac{\ddot{a}_{63:2}}{\ddot{a}_{61:4}} = 0.47582$$

$$3V = 1 - \frac{\ddot{a}_{64:1}}{\ddot{a}_{61:4}} = 0.73133$$

age	a_x	a_x^s	$a_x^{\overline{s}}$
61	0.006433	0.05	0.04969
62	0.006626	0.05	0.04952
63	0.011344	0.05	0.04913
64	0.012716		

T	a_T	a_T^p
1	0.943387	0.94389
2	0.940784	
3	0.939226	0.88799
4	0.987284	0.83403

Year	1	2	3	4
Premium	117250.7681	117250.7681	117250.7681	117250.7681
Expenses	800	3031.27	3031.27	3031.27
Opening Res	0	116200	237910	865165
Net Inc	5822.53	11520.97	17606.47	239942
Death claim	3216.50	4848.0	5772	6358
Surv claim	5825	11612.52	17387.12	
Mature claim				493642
Closing res	109679.67	223,820.92	343442	-
Profit	3552.12	1658.04	3234.78	3878.72
Profit Signature	3552.12	1565	2872.42	3234.97
Risk factor	0.9259	0.8573	0.7938	0.735
NPV	3289	1341.74	2280.25	2377.86

Prem	117250.768	117250.768	117250.768	117250.768
$t=1 \frac{V}{[1+i]}$	1	0.94389	0.88791	0.83403
Discount factor	1	0.925926	0.857337	0.793832
NPV	117250.77	102473.91	89283.98	77629.38

Profit margin = $\frac{\sum \text{NPV of Profit signature}}{\sum \text{NPV of Premium}} = 2.402\%$

29.

n	$(a_p)^d_x$	$(a_p)^s_x$	$(a_p)^x$	$x \cdot a_p^x$
42	0.000922	0.099908	0.899170	1
43	0.001150	0.09885	0.898965	0.899170
44	0.001321	0.00000	0.998173	0.898323

Unit fund Year	1	2	3
Fund at start	0	3148.4	11784.59
Allocated Prem	3000	8000	9200
Bidoffer	75	200	231.25
Interest	263.25	985.36	1872.30
AME	39.85	149.17	283.45
Unit fund at end	3148.5	11784.59	22392.19

Non unit cashflows	1	2	3
Year			
Unallocated prem	7000	2000	750
Bid offer spread	75	200	231.25
Exp	2000	750	200
Commission	1000	300	300
Int	285.25	80.50	-4.81
AMC	39.85	149.17	283.45
Death cost	15.54	9.45	0
Maturity cost	0	0	3354.37
End of year cashflow	4384.53	1370.22	-3144.28
Interest prob	1	0.899170	0.808323
Disc factor	0.89492	0.783147	0.679050
Premium signature	10000	8991.7	8083.23

$$\text{EPV Profit Margin} = \frac{\text{EPV of Profit}}{\text{EPV of Prem}} = \frac{3083.46}{24287.61} = 12.70\%$$

ii) Reserves do not reduce profits, they only defer release of profits

So if interest earned on reserves is equal to discount rate, there is no effect of deferring the profit as the opportunity cost on money held as reserves is zero.

iii) Since $2U = \frac{4532.25}{1.07} = 4235.75$

$$1V \times 1.07 - (ap_{43} \times 2U) = 760.10$$

$$\Rightarrow V = 4269.06$$

$$\therefore \text{Year 2} = 4235.75 \times (ap)_{43} = 3807.29$$

$$\text{Year 1} = 4269.06 \times (ap)_{42} = 3838.61$$

Q10.

Unit fund :-

Year	1	2	3	4
Prem allocated	1.7500	2.7500	2.7500	2.7500
Cost of allo	157.50	247.50	247.50	247.50
Fund at start	157.50	41018.24	67920.07	96581.1
Fund before charge	16852.5	43829.52	72674.47	103320.39
FMC	84.26	219.45	365.37	516.60
Policy fees	500	500	500	500
Fund at end	16268.24	43170.02	71811.1	102303.79

Non unit

Profit on alloc	9250	250	250	250
Expenses	3500	1100	1100	1100
Non-unit int	402.50	-59.5	-59.5	-59.5
FMC	84.26	219.45	365.37	516.60
Policy fees	500	500	500	500
Non unit death cost	730.98	327.45	0	0
Profit	6005.78	-517.5	-46.13	107.10

ii)

Non-unit reserves :-

$$\text{Start of year 3} = \frac{46.13}{1.07} = 43.11$$

$$\begin{aligned} \text{End of year 2} &:- 43.11 \times 0.985 + 517.50 = 559.96 \\ \text{Start of year 2} &= \frac{559.96}{1.07} = 523.33 \end{aligned}$$

$$\text{End of year 01} = 523.33 \times 0.985 = 515.48$$

Year	1	2	3	4
Non unit reserve	0	523.33	43.11	0
Int. on reserves	0	36.33	3.02	0
Increase reserves	515.48	-480.87	-43.11	0
Profit ignoring reserves	6005.78	-517.50	-46.13	107.10
Profit allowing reserves	5490.30	0	0	107.10