444 HW 4

Key

April 10, 2024

1a) Corridor factors make sure that UL policies meet the definition of a life insurance policy by specifying a minimum requirement for the death benefit. Since Type A policies have a death benefit that consists of just the specified amount, while Type B UL policies have a death benefit made up of both the specified amount and the account value, Type A policies usually have a smaller nominal death benefit. Thus, they are more likely to fall out of compliance with the minimum death benefit requirements set by the corridor factors.

1b) $\text{NAR}_t = SA = 100000$
$\text{COI}_1 = (SA/1000) * r_c * 1.04^{-1} = (SA * q_{75}) * 1.04^{-1}$
$\text{COI}_1 = 100000 * .018433 * 1.04^{-1} = 1772.40$

1c) $\text{AV}_1 = [AV_0 + 10000(1 - .1) - 100 - COI_1] * 1.07$
$\text{AV}_1 = [9000 - 100 - 1772.40] * 1.07$
$\text{AV}_1 = 7626.53$

1d) $\text{AV}_1 = [AV_0 + 10000(1 - .1) - 100 - q_{75} * 1.04^{-1} * (100000 - AV_1)] * 1.07$
$(\text{AV}_1/1.07) - (q_{75} * AV_1)/1.04) = AV_0 + 9000 - 100 - (q_{75}/1.04) * (100000)$
$\text{AV}_1 = [0 + 9000 - 100 - (.018433/1.04)(100000)]/[(1/1.07) - (.018433/1.04)]$
$\text{AV}_1 = 7773.96$

1e) $\text{AV}_9 = [AV_8 + 10000(1 - .1) - 100 - q_{83} * 1.04^{-1} * (100000 - AV_9)] * 1.07$
$(\text{AV}_9/1.07) - (q_{83} * AV_9)/1.04) = AV_8 + 9000 - 100 - (q_{83}/1.04) * (100000)$
$\text{AV}_9 = [AV_8 + 9000 - 100 - (.045968/1.04)(100000)]/[(1/1.07) - (.045968/1.04)]$
$\text{AV}_9 = 96698.82$ without corridor factor
$96698.82(1.05) = 101533.76$ so the corridor factor applies
with the corridor factor,
$(\text{AV}_9/1.07) = AV_8 + 10000(1 - .1) - 100 - (.045968/1.04)(AV_9(1.05) - AV_9)$
$(\text{AV}_9/1.07) + (.045968/1.04)(.05 * AV_9) = AV_8 + 9000 - 100$
$\text{AV}_9 = [81618.64 + 8900]/[(1/1.07) + .045968(.05)/1.04]$
$\text{AV}_9 = 96626.45$

2a) $\text{AV}_9 = [AV_8 + 7000(.94) - 55 - (2/1000)(1.05^{-1})(150000 - AV_9)] * 1.06$
$(\text{AV}_9/1.06) - (.002/1.05)(AV_9) = 62000 + 6580 - 55 - (.002/1.05) * (100000)$
$\text{AV}_9 = 68239.29/[(1/1.06) - (.002/1.05)] = 72480$
72480(1.97) is less than 150000 so the corridor factor doesn't apply

2b) The corridor factor will apply. Thus,
$\text{AV}_{10} = [6580 + AV_9 - 55 - (.0022/1.05)((1.91)AV_{10}) - AV_{10}] * 1.06$
$(\text{AV}_{10}/1.06) + (.0022/1.05)(.91 * AV_{10}) = 6580 + 72480 - 55$
$\text{AV}_{10} = 79005/[(1/1.06) + (.0022 * .91)/(1.05)] = 83576$

2c) $\text{DB}_{10} = 1.91(AV_{10}) = 1.91(83576)$
$\text{EDB}_{10} = [1.91(83576) + 250] * q_{49}$
$\text{EDB}_{10} = .0011 * [1.91(83576) + 250] = 175.9$

2d) $\text{Pr}_{10} = [72480 + 7000(1 - .05) - 45](1.075) - EDB_{10} - ECSV_{10} - EAV_{10}$
$\text{EAV}_{10} = AV_{10} * (1 - .0011) * (1 - .15) = 70961$
$\text{ECSV}_{10} = (1 - .0011) * (.15) * (AV_{10} - SC_{10} + 100$
$\text{ECSV}_{10} = (1 - .0011) * .15 * (83576 - 1500 + 100) = 12313$
$\text{Pr}_{10} = [72480 + 7000(.95) - 45](1.075) - 12313 - 175.9 - -70961$
$\text{Pr}_{10} = 1566$

2e) $\Pi_{10} = Pr_{10} * {}_9p_{40}^{(\tau)}$
Use these formulas to fill in the table at the top of the page
$p_x^{(\tau)} = (1 - q_x^{death}) * (1 - q_x^{surrender})$
$\ell_x = \ell_{x-1} * p_{x-1}^{(\tau)}$
${}_9p_{40}^{(\tau)} = 828.264/1000 = .828264$
$\Pi_{10} = .828264(1566) = 1297$

2f) 1. Regulators may require the insurer to hold reserves higher than the AV.

2. The insurer may decide to sacrifice some profitability in order to better protect against mortality risk by holding higher reserves, thereby reducing the impact of unexpectedly unfavorable mortality experience.

3. If a corridor factor is needed, holding larger reserves will reduce the chance of needing to borrow money due to the newly increased benefit requiring higher reserves and higher possible payouts.

4. Holding larger reserves will reduce the unfavorable financial impact that early surrenders might have on the insurer's profitability.

t	*x*	*lx*	*qx*	*surrender %*	*pxtau*
1.00000	40	1000	0.000527	0.02	0.979483
2.00000	41	979.483	0.000565	0.02	0.979446
3.00000	42	959.351	0.000608	0.02	0.979404
4.00000	43	939.592	0.000656	0.02	0.979357
5.00000	44	920.196	0.000710	0.02	0.979304
6.00000	45	901.152	0.000771	0.02	0.979244
7.00000	46	882.448	0.000839	0.02	0.979177
8.00000	47	864.073	0.000916	0.02	0.979102
9.00000	48	846.015	0.001003	0.02	0.979018
10.00000	49	828.264	0.001100	0.15	0.849065

Figure 1: Excel table for Problem 2e