ACSC/STAT 4720, Life Contingencies II
Fall 2016

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Homework Sheet 5

Due: Friday 18th November: 12:30 PM

Basic Questions

1. An insurance company sells a 5-year annual life insurance policy to a life aged 29, for whom the lifetable below is appropriate.

x	l_x	d_x
29	10000.00	0.88
30	9999.12	0.95
31	9998.17	1.03
32	9997.15	1.11
33	9996.04	1.21
34	9994.83	1.31

The annual gross premium is \$152. Initial expenses are \$90 plus 25% of the first premium. The death benefits are \$1,200,000. Renewal costs are 3% of each subsequent premium. The interest rate is $i = 0.03$

(a) Calculate the expected net cash-flows associated with this policy (assuming no reserve). [This is the profit vector for the policy.]

(b) Which of the following is the internal rate of return of the policy:

(i) $i = 0.041241$

(ii) $i = 0.049045$

(iii) $i = 0.055031$

(iv) $i = 0.061620$

2. An insurance company sells a 5-year annual life insurance policy to a life aged 44, for whom the lifetable below is appropriate.

x	l_x	d_x
44	10000.00	7.25
45	9992.75	8.01
46	9984.74	8.85
47	9975.89	9.78
48	9966.11	10.81
49	9955.30	11.95

The annual gross premium is \$720. Initial expenses are \$130 plus 20% of the first premium. The death benefits are \$720,000. Renewal costs are 4% of each subsequent premium. The interest rate is $i = 0.03$. Reserves are calculated on the basis $i = 0.02$, with mortality following the table.

(a) Calculate the reserves.

(b) Calculate the profit signature.

(c) Calculate the profit margin at a risk discount rate of $i = 0.06$.

3. For the policy in Question 2:

   (a) Calculate the reserves and profit signature for a general premium. [You may assume that P is such that the reserves are zero in Years 1 and 2.]

   (b) Calculate the premium that gives an internal rate of return of $i = 0.10$.

4. For a 5-year term insurance policy sold to a life aged 44, and actuary performs the following profit test without reserves:

Year	Premium	Expenses	Interest	Expected Death Benefits	$\Pr_t$
0		1500			−1500
1	5900	0	177.00	4216.80	1860.20
2	5900	80	174.60	4806.66	1187.94
3	5900	80	174.60	5478.02	516.58
4	5900	80	174.60	6243.89	−249.29
5	5900	80	174.60	7117.12	−1122.52

   Calculate the reserves needed to ensure that all cash flows are non-negative.

Standard Questions

5. A couple purchase a 5-year last survivor insurance policy. Annual Premiums of \$19,830 are payable while both are alive. If one life is dead, there are no premiums or benefits. If both lives die within the 5-year period, a benefit of \$1,000,000 is payable. The husband is 74 and the wife is 81. Their lifetables are given below. Assume both lives are independent.

x	l_x	d_x
74	10000.00	591.85
75	9408.15	628.62
76	8779.53	662.27
77	8117.26	691.27
78	7425.99	713.96
79	6712.03	728.54

x	l_x	d_x
81	10000.00	1113.81
82	8886.19	1114.43
83	7771.76	1097.45
84	6674.31	1061.21
85	5613.10	1004.92
86	4608.18	928.94

   Initial expenses are \$3,000, and renewal expenses are \$80 at the start of each subsequent year while both are alive, and \$60 at the start of each year while only one is alive. The interest rate is $i = 0.04$. Use a profit test without reserves to determine the NPV of this policy at a risk discount rate of $i = 0.10$.