Coursework

Imperial College London

Department of Mathematics

M3S14 - Survival Models and Applications

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1 Question 1

(a) 30 year old female, 1 year life insurance, upfront premium is:

$$q_{30} \cdot 200000 = 75.00 \quad \text{GBP}$$

(b) 50 year old male. Insurance covering the next 10 years. Upfront premium is:

$$_{20}q_{50} \cdot 200000 = \left(1 - \prod_{i=0}^{9}(1 - q_{50+i})\right) \cdot 200000 = 9540.64 \quad \text{GBP}$$

Code used for this question:

```
# QUESTION 1

payout = 200000

# Part a
q_30 = 0.000375
premium1 = 200000*0.000375
# premium1 = 75


# Part b
q_50_to_60 = c(0.003402, 0.003501, 0.003813, 0.003968,
               0.004408, 0.004923, 0.005467, 0.005868,
               0.006371, 0.007031)
premium2 = (1 - prod(1 - q_50_to_60))*200000
# premium2 = 9540.64
```

2 Question 2

The code used for question 2:

```
# Using method UDD

likelihood1 = function(q, a, b, d){
  baqxa = (b*q - a*q)/(1 - a*q)
  res = prod((baqxa**d)*((1-baqxa)**(1-d)))
}

qx1 = optimize(likelihood1, interval=c(0, 1), a, b, d, maximum=TRUE)
# qx1 = 0.462

# Using method Balducci assumption

likelihood2 = function(q, a, b, d){
  aq = 1 - (1 - q)/(1 - (1 - a)*q)
  bq = 1 - (1 - q)/(1 - (1 - b)*q)
  baqxa = (bq - aq)/(1 - aq)
  res = prod((baqxa**d)*((1-baqxa)**(1-d)))
}

qx2 = optimize(likelihood2, interval=c(0, 1), a, b, d, maximum=TRUE)
# qx2 = 0.466

# Using method Constant Force of Mortality:

likelihood3 = function(q, a, b, d){
  aq = 1 - (1 - q)**a
  bq = 1 - (1 - q)**b
  baqxa = (bq - aq)/(1 - aq)
  res = prod((baqxa**d)*((1-baqxa)**(1-d)))
}

qx3 = optimize(likelihood3, interval=c(0, 1), a, b, d, maximum=TRUE)

# qx3 = 0.469
```

The three methods are coded above, and the results I get are 1. Uniform Distribution of Deaths: $q_x = 0.462$, 2. Balducci Assumption: $q_x = 0.466$, 3. Constant Force of Mortality: $q_x = 0.469$.

We can see that the three methods give very similar q_x and we can say that all three methods are valid.