STAT3032 SURVIVAL MODELS

TUTORIAL WEEK TWELVE

Question One

A multiple state model has been suggested as a representation of the lifecycle of new boutique fund managers during their first year of operation. The model has three states: *operating* (state 1), *bankrupt* (state 2), and *sold* (state 3). In this model transitions are only possible from the operating state into the bankrupt state and from the operating state into the sold state. The transition intensities for both of these movements are assumed constant. Denote these two intensities by μ and ν, respectively.

a) The following data were observed for 7 new boutique fund managers:

Company	Start	End	Bankrupt	Sold
1	0	1	1	0
2	0	0.7	0	0
3	0	0.3	1	0
4	0.5	1.5	0	0
5	0.8	1	0	1
6	0.2	1	0	0
7	0	2.3	0	0

Key:
Start = The age of the company when it entered observation.
End = The age of the company when it ceased being observed.
Bankrupt = Whether the company ceased being observed due to bankruptcy.
Sold = Whether the company ceased being observed due to it being sold.

Based on this data provide estimates of the two transition intensities.

b) Estimate the probability that 14 or more of a group of 100 new boutique fund managers will go bankrupt during their first 6 months of operation.

Question Two

A study was conducted to study the relative survival rates of breast cancer patients whose treatment was breast conserving surgery compared with mastectomy, adjusting for other covariates including tumour size and nodal status. The output from a Cox regression model fit to this data is shown below:

Covariate	Coefficient	Standard Error
Age	-0.1	0.033
Squared Age	0.0011	0.0003
1-3 nodes	0.75	0.17
> 3 nodes	1.47	0.18
Surgery	-0.82	0.17
Tumour Size	0.051	0.015
Squared Tumour Size	-0.00048	0.0002

Here, *Age* is the patient's age in years, *nodes* is a categorical variable with three categories (0 nodes, 1-3 nodes, > 3 nodes), *surgery* is an indicator variable that takes the value 1 for patients who had breast conserving surgery and 0 for patients who had a mastectomy, and *tumour size* is the size of the tumour in mm.

a) Based on the fitted model, what can you say about the hazard of death for patients whose treatment was breast conserving surgery compared to patients whose treatment was mastectomy, everything else constant?

b) Is the surgery covariate significant in determining mortality? Justify your answer.

d) Approximately what age would a patient undergoing breast-conserving surgery have to be in order to have the same hazard of death as a 65 year old undergoing mastectomy, everything else constant?

e) If the hazard function at time t after an operation was defined to be $h(t) = \alpha\lambda t^{\alpha-1}$ in such a way that:

$$\alpha = \alpha_0 + \alpha_1 Z_1$$
$$\lambda = \lambda_0 + \lambda_1 Z_2$$

where $\alpha_0, \alpha_1, \lambda_0, \lambda_1$ are constants and Z_1 and Z_2 are covariates. Show that these hazards are not in general proportional. Are there any values of $\alpha_0, \alpha_1, \lambda_0, \lambda_1$ where these hazards are proportional?

Question Three

Show that $e_x = p_x(1+e_{x+1})$.

4. You are interested in the mortality experience of female elite athletes. At both the start and end of 2011 there were 547 female elite athletes in your county. You also have information on the number of elite athletes at 1 June 2011 (325 athletes) and 1 September 2011 (613 athletes). Approximately, calculate the central exposed to risk over the year.