

EC968 Panel Data Methods (Survival Analysis)

Formative assessment

1. The survival function for the exponential model for continuous time duration is $S(t) = \exp(-\lambda t)$.
- (a) [10 marks] Derive the hazard function. Derive and discuss expressions showing how the survival and hazard functions vary with time.
- (b) [10 marks] Suggest how to allow for differences in characteristics in the hazard function. Compute the ratio of the hazard functions for two individuals with equal durations but different vectors of characteristics x and z . Discuss how the two hazard functions would differ if the two individuals were identical except for a variable x_k taking value $(c+1)$ for the first individual and c for the second individual.

The following table presents estimates of an Exponential and a Cox model of the hazard of re-arrest following release from prison for a sample of 432 men released from Maryland prisons. The hazard function of a Cox model is equal to $h(t) = \theta_0(t) \exp(\beta'x)$ where $\theta_0(t)$ is the baseline hazard.

- (c) [10 marks] Discuss the theoretical differences between the Cox and Exponential model, especially in terms of the baseline hazard and what that means for the form of their duration dependence.
- (d) [10 marks] Considering the Exponential model estimates, discuss the estimated relationship between the hazard rate of criminal recidivism and each of the explanatory variables, paying particular attention to the magnitude of the effects and their statistical significance.
- (e) [10 marks] Assess, algebraically, whether (i) the Exponential model and (ii) the Cox model have the proportional hazard (PH) property or the accelerated failure time (AFT) property.

Data table is on the following page

Table. Estimated parameters of two hazard regression models of criminal recidivism

	Exponential model			Cox model		
	β	$ t $	$\exp(\beta)$	β	$ t $	$\exp(\beta)$
Received financial aid when in prison *	-0.33	1.69	0.72	-0.34	1.76	0.71
Age at release (years)	-0.07	2.89	0.94	-0.07	2.94	0.93
Race is black *	0.28	0.90	1.32	0.29	0.92	1.33
Had prior work experience *	-0.12	0.53	0.89	-0.12	0.55	0.89
Married *	-0.41	1.08	0.66	-0.43	1.11	0.65
Release on parole *	-0.04	0.19	0.96	-0.04	0.18	0.97
Number of previous arrests	0.10	0.21	1.10	0.10	3.36	1.11
Age at earliest arrest (years)	0.07	2.30	1.07	0.07	2.40	1.07
Education (years)	-0.26	1.96	0.77	-0.26	1.96	0.77
Had a job after release *	-0.04	1.76	0.96	-0.04	1.78	0.96
Constant	-3.86	2.50	0.02	n/a	n/a	n/a

Adapted from Allison, P.A. (1984), *Survival Analysis*, Sage, p. 27.

*: dummy variable.

n/a: not applicable.

$|t|$: absolute value of the ratio of estimated parameter to standard error. $|t| > 1.96$ corresponds to a p-value lower than 0.05.

[based on the exam in Session 2010–2011]

Return the assessment to Claire Cox, in the Economics Department by **12 noon, Friday 24 February 2012**. Ensure that your work is appropriately identified (name, email address), is legible, pages stapled together, etc. I will aim to mark the material as soon as possible and return it to you, with comments, within 10 days.

Mike Brewer