

LECTURE WEEK 5 Supplement
Spring 2005
February 8 and 11

TMA4275 LIFETIME ANALYSIS

Bo Lindqvist

Department of Mathematical Sciences
NTNU

bo@math.ntnu.no
<http://www.math.ntnu.no/~bo/>

1

Why parametric models?

- **Complements nonparametric techniques.**
- **Parametric models can be described concisely with just a few parameters, instead of having to report an entire curve.**
- **It is possible to use a parametric model to extrapolate (in time) to the lower or upper tail of a distribution.**
- **Parametric models provide smooth estimates of failure-time distributions. In practice it is often useful to compare various parametric and nonparametric analyses of a data set.**

2

Motivation for the exponential distribution

- Simplest distribution used in the analysis of reliability data.
- Has the important characteristic that its hazard function is constant (does not depend on time t).
- Popular distribution for some kinds of electronic components (e.g., capacitors or robust, high-quality integrated circuits).
- This distribution would not be appropriate for a population of electronic components having failure-causing quality-defects.
- Might be useful to describe failure times for components that exhibit physical wearout only after expected technological life of the system in which the component would be installed.

3

Motivation for the Weibull distribution

- The theory of extreme values shows that the Weibull distribution can be used to model the minimum of a large number of independent positive random variables from a certain class of distributions.
 - Failure of the weakest link in a chain with many links with failure mechanisms (e.g. fatigue) in each link acting approximately independent.
 - Failure of a system with a large number of components in series and with approximately independent failure mechanisms in each component.
- The more common justification for its use is empirical: the Weibull distribution can be used to model failure-time data with a decreasing or an increasing hazard function.

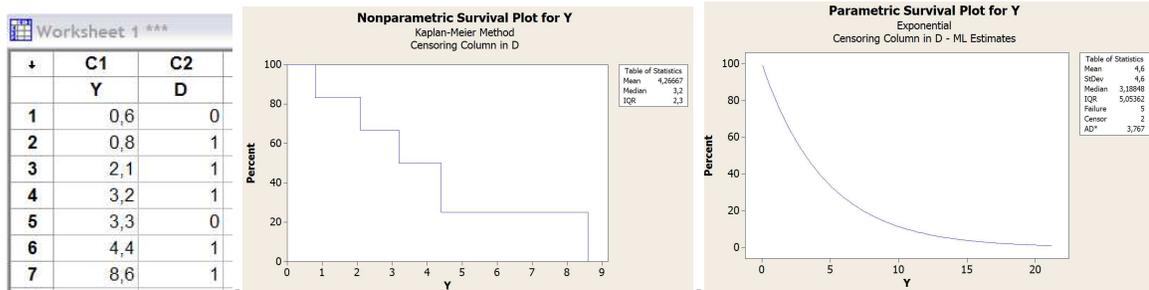
4

Motivation for lognormal distribution

- The lognormal distribution is a common model for failure times.
- It can be justified for a random variable that arises from the product of a number of identically distributed independent positive random quantities (remember central limit theorem for sum of normals).
- It has been suggested as an appropriate model for failure time caused by a degradation process with combinations of random rates that combine multiplicatively.
- Widely used to describe time to fracture from fatigue crack growth in metals.
- Useful in modeling failure time of a population electronic components with a decreasing hazard function (due to a small proportion of defects in the population).
- Useful for describing the failure-time distribution of certain degradation processes.

5

Nonparametric and parametric survival plots for data from exponential example



6