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Research Article

Statistical inference of step-stress partially accelerated life tests for the Chris-Jerry distribution under type-I censored data with engineering applications

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Abstract

In this article, we focus on the parametric inference of the Chris-Jerry distribution under Type-I censoring using the tampered random variable model within the framework of step-stress partially accelerated life tests. It is assumed that the lifetimes of the test units follow the Chris-Jerry distribution. Various estimation techniques are used to estimate the model parameters. In addition, asymptotic confidence intervals for the parameters are derived using the Fisher information matrix. The practical applicability of the proposed methods is demonstrated through the analysis of a real data set involving AT-II PHCS and the breaking stress of carbon fibers. Numerical results based on Markov Chain Monte Carlo simulations indicate that the mean squared error, bias and relative absolute bias decrease as the sample size increases.

Mathematics Subject Classification (2020). 62E10, 62F15, 62N05, 60E05, 62P30

Keywords. Accelerated life testing, Chris-Jerry distribution, tampered random variable, type-I censoring, maximum likelihood estimation, least square estimation, probability integral transform

1. Introduction

In reliability engineering, accelerated life testing (ALT) plays a crucial role in enabling the rapid acquisition of failure data for products, which would otherwise require considerable time and cost under normal usage conditions. Due to the extended lifetimes of many modern products, collecting sufficient failure information in typical service environments is often impractical. As a result, ALT has become increasingly important in reliability studies. In ALT, test units are subjected to one or more stressors at elevated levels to induce early failures. The resulting failure data are analyzed and extrapolated to estimate the reliability characteristics of the product under normal operating conditions.

There are several continuous probability distributions that are commonly used in the statistical literature for modeling lifetime data, including the Weibull, Lindley, gamma, log-normal and exponential distributions. Among these, the gamma and log-normal distributions have survival functions that lack closed-form expressions, requiring numerical

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