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A Bivariate Inverse Gaussian-Wiener Degradation Model Applied to Reliability Assessment

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Abstract: Generally, the quality of a product is a function of the degradation of multiple performance characteristics, such that a failure of a product may be described when any of the multiple characteristics reach a critical level. Thus, a failure comes from a competing process in which it is important to consider the joint behavior of the degradation of the performance characteristics. Furthermore, the degradation process of every characteristic may be different in their nature, such that the degradation paths of a characteristic may be non-monotone, and for some characteristics, the degradation paths may be monotone. If a monotone stochastic process is adjusted to non-monotone degradation paths and vice versa, the reliability assessment of the product may be inaccurate. In this article, a bivariate degradation model with inverse Gaussian and Wiener marginal processes is proposed. The joint modeling is developed by considering the Frank copula. It is well known, that the inverse Gaussian process has monotone increasing paths, while the Wiener process has non-monotone increasing paths, such that the two possible behaviors of the degradation paths are considered. The proposed model is illustrated with a degradation dataset, and it is estimated via a Bayesian approach. In addition, some important insights are provided.

Keywords: Degradation, Stochastic Process, Inverse Gaussian, Wiener, Reliability