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Quantile Regression via Accelerated Destructive Degradation Modeling for Reliability Estimation

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Along with the shortening of production period, manufacturing industry utilizes an accelerated degradation test (ADT) to estimate the reliability of newly developed products as quickly as possible. In ADT, the stress factor which is related to the failure mechanisms is imposed to cause the failure of products faster than those under normal use condition. By increasing the degree of stress such as voltage, temperature, humidity or other external factors, the performance of new products continuously degrades and leads to the failure. In some applications, accelerated destructive degradation test (ADDT) is conducted when testing units should be destroyed to measure the performance of the degrading product.

For general ADT and ADDT models, the mean estimators have been considered as the location measurement. However, the estimation result using mean estimator can be inappropriate for highly skewed data, because the lifetime estimation of degradation data with outliers or irregularity can be distorted.

In this paper, the ADDT modeling based on quantile regression (QR) is suggested as a comprehensive approach for asymmetric observations. QR-based ADDT requires fewer assumptions than the general parametric methods to construct the model, and enables the interpretation to be more flexible. Through the data application, our approach provides a great advantage by inferring a nonlinear degradation path without bias and partiality.

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