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ASSESSING AGREEMENT BETWEEN TWO MEASUREMENT SYSTEMS USING REPLICATED SCALE MIXTURES OF SKEW-NORMAL MEASUREMENT ERROR MODELS WITH VARYING DEGREES OF FREEDOM

J. Duwarahan[1, 2*] and L.S. Nawarathna[3]

[1]Postgraduate Institute of Science, University of Peradeniya, Sri Lanka.
[2]Department of Mathematics & Statistics, Faculty of Science, University of Jaffna, Sri Lanka.
[3]Department of Statistics & Computer Science, Faculty of Science, University of Peradeniya, Sri Lanka.
[*]jeevana@univ.jfn.ac.lk

Method comparison studies are commonly conducted in health fields to evaluate the interchangeability of a new method for measuring a continuous variable with an established reference method. The agreement between two methods that measure the same variable but are prone to measurement errors is often evaluated by measurement error models, which are assumed to be normal. However, normality may not hold when dealing with skewed and heavy-tailed data. To address this issue, a replicated measurement error model (RMEM) is proposed for analysing replicated method comparison data with different levels of heaviness in the tails of true covariates and errors under scale mixtures of skew-normal (SMSN) distributions. The model, which includes skew-t (ST), skew generalized-t (SGT), and skew-slash (SS) distributions, is called generalised scale mixtures of skew-normal RMEM (GSMSN-RMEM). The proposed methodology is evaluated through a simulation study using root mean square error measures for sample sizes of n = 50, 100, and 200, and the expectation conditional maximisation approach is applied to fit the model. The simulation results indicate that ST and SGT distributions outperform the skew-normal distribution, possibly due to their heavy-tailed characteristics. Furthermore, the methodology is demonstrated by analysing systolic blood pressure data, and model selection is employed using the Akaike information criterion and Bayesian information criterion. The agreement between methods is assessed using the unconditional probability of agreement, and it is found to be higher for SGT (nearly 0.95) and ST (nearly 0.90) distributions compared to other distributions. The study demonstrates that the proposed method, GSMSN-RMEM under ST and SGT distributions, is an effective tool for evaluating the agreement between two measurement systems when dealing with measurement errors and skewed and heavy-tailed data. This method can be applied in various fields, such as biomedical engineering, clinical research, and medical imaging.

Keywords: Assessing agreement, Expectation conditional maximisation, Heavy-tailed distributions, Probability of agreement, Replicated measurement error models.