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Enhanced Finite Population Mean Estimation Through Dual Auxiliary Information: A Novel Approach Using Original Values and Ranked Data

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Abstract: *This research presents an innovative estimator for finite population mean that simultaneously utilizes auxiliary variable values and their corresponding ranks to achieve superior estimation efficiency. Traditional ratio, product, and regression estimators rely solely on auxiliary variable values, potentially overlooking valuable information contained in the ranking structure. Our proposed methodology incorporates both the auxiliary variable and its rank transformation through a generalized exponential framework, creating a dual-information approach that significantly improves estimation precision. Through rigorous mathematical derivations, we establish the bias and mean squared error (MSE) properties under first-order approximation. Extensive numerical analysis across five diverse real-world datasets demonstrates that our estimator consistently outperforms classical estimators including simple mean, ratio, product, exponential, regression, and several contemporary modified estimators. The theoretical comparisons reveal that our approach achieves superior efficiency conditions, while empirical results show percentage relative efficiency gains ranging from 15% to 87% across different population structures. This research contributes to survey sampling theory by demonstrating how rank-based auxiliary information can be systematically integrated with traditional auxiliary data to enhance estimation accuracy in finite population inference.*

Keywords: Auxiliary information, finite population mean, rank transformation, exponential estimator, survey sampling, dual information approach, efficiency comparison

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