

Empirical likelihood bivariate nonparametric maximum likelihood estimator with right censored data

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Abstract This article considers the estimation for bivariate distribution function (d.f.) $F_0(t, z)$ of survival time T and covariate variable Z based on bivariate data where T is subject to right censoring. We derive the empirical likelihood-based bivariate nonparametric maximum likelihood estimator $\hat{F}_n(t, z)$ for $F_0(t, z)$, which has an explicit expression and is *unique* in the sense of empirical likelihood. Other nice features of $\hat{F}_n(t, z)$ include that it has only nonnegative probability masses, thus it is monotone in bivariate sense. We show that under $\hat{F}_n(t, z)$, the conditional d.f. of T given Z is of the same form as the Kaplan–Meier estimator for the univariate case, and that the marginal d.f. $\hat{F}_n(\infty, z)$ coincides with the empirical d.f. of the covariate sample. We also show that when there is no censoring, $\hat{F}_n(t, z)$ coincides with the bivariate empirical d.f. For discrete covariate Z , the strong consistency and weak convergence of $\hat{F}_n(t, z)$ are established. Some simulation results are presented.

Keywords Bivariate data · Bivariate right censored data · Doubly censored data · Empirical likelihood · Maximum likelihood estimator · Right censored data