

# "Silverman Rules" for Regression Quantile Covariance Estimation

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## Abstract

Standard errors formulae for quantile regression that are robust to heteroskedasticity and involve kernel density estimators can perform poorly in simulations, especially when the regression design is highly leveraged. This paper investigates common rule for the choice of tuning parameter (bandwidth) and argues that they yield bandwidths that can be too small, overweighting bias relative to variance. We propose modifications of the traditional "Silverman Rule" for bandwidth choice that account for differences in quantile ( $\tau \in (0,1)$ ) and design matrix  $X$  in the regression setting, typically yielding larger bandwidths than the usual rules (which implicitly ignore the variability of the regressors). The proposed rules differ depending upon whether the objective is to minimize the mean-squared error of the estimated standard error or to minimize the difference of an Edgeworth approximation of distribution of the t-statistic from a standard normal distribution. In both cases the "effective sample size" for bandwidth selection is smaller in the regression case than for marginal (univariate) kernel density estimation, sometimes dramatically so, leading to much larger optimal bandwidths than used in statistical software.