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DISCUSSION

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First I would like to congratulate the authors for developing a new concept of directional quantile contours. The work will contribute well to the pursuit of multivariate quantiles. The multiple output regression provides a new way of estimating the conditional multivariate quantile functions, which will certainly facilitate a large number of applications. I enjoy the paper for its mathematical rigor and computational savvy. My discussion will focus on the modeling aspect of conditional multivariate quantiles.

1. Choice of models. When one tries to incorporate covariate information into multivariate quantiles, certain model assumptions have to be made. As in any regression methods, there are various levels of modeling, for example, linear or nonlinear, parametric or nonparametric. In any application, an appropriate choice of the model matters. I will illustrate this point in my discussion using the same data set as in Hallin, Paindaveine and Šiman (2010). I will later discuss a generalization of the multiple output regression to nonparametric models, and comment on the challenges in model adequacy assessment for the multiple output regression.

To illustrate the main point, let us apply the conditional reference quantiles of Wei (2008) to the same data set in Hallin, Paindaveine and Šiman (2010). The response variables are the calf maximal circumference, denoted as Y_1, and the thigh maximal circumference, denoted as Y_2. The covariates include age, height, weight and BMI. To make results comparable to those of Hallin, Paindaveine and Šiman (2010), let us estimate the conditional bivariate reference quantile contours of calf and thigh circumferences given the subject's height, weight, age and BMI, separately, as the authors did in their illustrative example. Men and women are analyzed separately. Following the two-step methods of Wei (2008), we first construct stratified quantile regression models for the conditional joint distribution of calf and thigh circumferences given a chosen covariate X. We consider two settings as follows.

1. Setting 1: linear stratified quantile models:

$$Q_{\tau|X}(Y_1) = \alpha_{\tau,1} + \alpha_{\tau,2}X,$$
$$Q_{\tau|X,Y_1}(Y_2) = \beta_{\tau,1} + \beta_{\tau,2}X + \beta_{\tau,3}Y_1.$$

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