

**QUANTILE REGRESSION AND REML APPROACH FOR  
ROBUST REGRESSION OF CLUSTERED DATA**

A THESIS PRESENTED BY

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TO THE

**SCHOOL OF STATISTICS**

AS PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE DEGREE OF  
**MASTER OF SCIENCE IN STATISTICS**

SCHOOL OF STATISTICS  
UNIVERSITY OF THE PHILIPPINES

DILIMAN, QUEZON CITY

**MAY 2016**

## Abstract

We proposed two procedures in the estimation of a linear mixed model. Quantile regression and REML are imbedded into the backfitting (QRB) to estimate fixed and random effects in a linear mixed model. We further introduce bootstrap in the imbedded quantile regression and REML in backfitting (BootQRB) algorithm. To assess the performance of the proposed methods, the simulations cover a wide range of scenarios including outliers and specification error. Both QRB and BootQRB are robust to misspecification errors, with high predictive ability and small standard errors (narrow LCI) across all quantiles compared to ordinary least squares and ordinary quantile regression. The proposed estimation methods are also robust to outliers, as exhibited in the estimates of quantiles near the tails of the distribution.

**Keywords:** *backfitting; bootstrap; linear mixed models; quantile regression; restricted maximum likelihood; robust method*