Bayesian Markov Switching Integer-valued GARCH Models for Dengue Counts

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The aim of this study is to model weekly dengue case counts with two climatological variables: average temperature and total precipitation. Since conventional zero-inflated integer-valued GARCH (generalized autoregressive conditional heteroscedasticity) models and the Poisson regression cannot properly illustrate successive zeros in weekly dengue counts, this paper proposes a Markov switching Poisson integer-valued GARCH model wherein a first-order Markov process governs the switching mechanism. This newly designed model has some interesting statistical features: lagged dependence, over-dispersion, successive zeros, nonlinear dynamics, and time-varying coefficients for the meteorological variables governed by a two-state Markov chain structure. We perform a parameter estimation and model selection within a Bayesian framework via a Markov chain Monte Carlo (MCMC) scheme. As an illustration, we conduct a simulation study to examine the effectiveness of the Bayesian method. To capture the characteristics of weekly dengue counts, we analyze 12-year weekly dengue case counts from five provinces in northeastern Thailand. The evidence herein strongly supports that the proposed Markov switching Poisson integer-valued GARCH model with two climatological covariates aptly describes successive zero, nonlinear dynamics, and seasonal patterns. The posterior probabilities deliver clear insight into the state changes captured in the modeled dataset. If the upper bound of predictive distribution exceeds a threshold, then the infectious disease early warning can announce an outbreak.

Keywords: Excessive and successive zeros, Label switching, Markov chain Monte Carlo method, Over-dispersion, Predictive credible intervals.