Never-Ending Developments in Time Series Analysis

Since the early work of Yule (1927, *Philos. Trans. Roy. Soc., Ser. A*, 226, 267-298), time series analysis has attracted much interest among statisticians and been widely used in practice. The papers in this special issue are vivid examples arising from such a long tradition, demonstrating the never-ending improvements and extensions of this important field of statistics. As is the case for many prior contributions, strong interaction between applications and theory motivates most of the works. These papers also show several emerging trends in time series analysis, including nonlinear and non-Gaussian models, conditional heteroscedasticity, methods to estimate the latent threshold variable, non-parametric or semi-parametric methods, multivariate models, continuous-time processes, and long memory.

Although linear Gaussian time series models provide good approximations to many real-world problems, they have their fair share of limitations, as clearly shown in many of the papers. The simple yet extremely useful idea of threshold, proposed by Tong (1978), goes a long way to overcome some of the limitations. For example, I knew that a river's flow depends on the temperature, but I did not appreciate the role that 32º Fahrenheit plays in statistical modeling until I used the threshold model. Many applications, however, do not have a clear threshold variable. Estimating the threshold variable is certainly a valuable new addition to this useful class of models.

Mean response has been the focus of most statistical analyses. Statisticians extend time series models by generalizing the mean equation. However, in some financial applications, the conditional variance is the main subject of interest. The price of a stock option depends critically on the volatility (conditional standard deviation) of the stock returns, which often have high excess kurtosis and are serially uncorrelated, but (are still) dependent. Analysis of financial time series thus requires use of innovations with heavy tails and conditional heteroscedasticity. Econometricians thus investigate the time evolution of the conditional second moment of a time series. The collaboration between econometricians and statisticians to develop a unified approach for handling time series data is long overdue. It is exciting to see papers in this special issue that deal with the first two moments jointly.

Nonlinear models come in different forms and shapes. Choosing a particular model from the nonlinear galaxy is as much science as it is art. Statistical theory provides useful guidance and can often direct us in the right direction. But without proper diagnostic checking, a statistical model might fare poorly in application. It is fitting to see that model selection and checking are both addressed in the issue.

Large and complicated data have become the norm of statistical analysis. Although univariate models are useful in practice, there are situations in which the dynamic dependence between the series is of main interest and multivariate models must be used. On the other hand, there are well-known difficulties such as the curse of dimensionality, identifiability, and lack of suitable software that prevent the widespread use of multivariate models. Nevertheless, dynamic factor or reduced rank models have the potential to overcome some of these difficulties. Therefore, it is gratifying to see that this special issue contains new developments in this area.

Research in time series analysis is diverse and advances rapidly. Therefore, it is not surprising that this special issue does not cover all topics in the area. However, in my opinion, the issue has exceeded an important threshold!

— Ruey S. Tsay

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