

Advanced Time Series – Syllabus

Course outline

1. Univariate time series (review and theory): causality and invertibility, linear processes, why is stationary Gaussian always linear? Ergodic nonlinear models, characteristics of nonlinear processes, mixing properties, ARMA, ARIMA and exponential smoothing, linear forecasting, trend and momentum forecasting.
2. Threshold models: TAR models, estimation and model identification, test for linearity, case studies with Canadian lynx, mink and muskrats.
3. Multivariate time series models: VAR, Granger causality, cointegration, PCA for vector time series, multivariate volatility models.
4. High-dimensional time series models: sparse VAR, banded VAR, factor models, testing high-dimensional white noise.
5. Selected topics from: functional time series, spatio-temporal data, spatial econometrics models, sequential Monte Carlo, matching quantile estimation for risk management, extreme quantiles for functions of dependent random variables.

References

- Box, G.E.P. and Jenkins, G.M. (1970). *Time Series Analysis, Forecasting, and Control*. Holden Day, San Francisco.

A classical work for time series analysis within the ARMA framework. Many examples used in the book are now classic. It gives a good guide into the practical aspects.

- Brockwell, P.J. and Davis, R.A. (1991). *Time Series: Theory and Methods, 2nd edition*, Springer-Verlag, New York.

It provides the theory for linear time series in depth, which should be a good reference for serious theorists. It contains lucid discussion on continuous AR models and analysis of heavy tailed time series.

- Cryer, J.D. and Chan, K.-S. (2008). *Time Series Analysis with Applications in R*. Springer, New York.

An excellent modern textbook for senior undergraduates and postgraduates with wide coverage and focus on methods and illustration by examples. The companion R package *TSA* enhances the learning experience substantially.

- Fan, J. and Yao, Q. (2003). *Nonlinear Time Series: nonparametric and parametric methods*. Springer-Verlag, New York.

It starts with a brief view on linear ARMA models, a snapshot of those in Brockwell & Davis (1991). The parametric nonlinear models TAR, GARCH and bilinear are presented compactly. It reflects the developments on nonparametric and semiparametric methods for time series upto early 2000. The principal focus is on methodologies, although many theoretical results are also presented.

- Fan, J. and Yao, Q. (2015). *The Elements of Financial Econometrics*.

Chapters 2-4 provide a compact view on linear ARIMA, volatility processes and multivariate AR models. The focus is on the methods with many real financial data examples.

- Priestley, M.B. (1981). *Spectral Analysis and Time Series*, Vols. 1 and 2, Academic Press, New York.

An excellent book with wide coverage as well as an in-depth account on spectral analysis. It should be widely readable since it uses mainly elementary mathematics.

- Shumway, R.H. and Stoffer, D.S. (2006). *Time Series Analysis and Its Applications with R Examples*. Springer-Verlag, New York.

Another excellent modern text with many interesting real data examples. It contains a chapter on state-space models.

- Tong, H. (1990). *Non-linear Time Series: A Dynamical Systems Approach*, Oxford University Press, Oxford.

It provides a comprehensive coverage of parametric nonlinear time series analysis up to the early 1990's. It also initiated the link between nonlinear time series and nonlinear dynamic system (chaos) and provoked the exciting development in this direction in last decade.

- Tsay, R.S. (2010). *Analysis of Financial Time Series*. Wiley, New York.

This book provides a comprehensive and systematic introduction to financial econometric models and their application to modelling and prediction of financial time series data. It utilizes many real financial data throughout the book.