

Linear and Nonlinear Time Series Models and their Applications

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The course will show how economic and financial time series can be modelled and analysed. The aim is to provide understanding and insight into the methods used, as well as explaining the technical details. Day 1 covers linear time series models and methodology, with applications in a variety of areas. Statistical modelling will be demonstrated using the new version of the STAMP computer package and participants will be given the opportunity to use STAMP in class. Day 2 focusses on the nonlinear models and the way in which they can be handled by the recently developed score-driven approach. The Time Series Lab (TSL) program will be used to model time series, with applications ranging from the analysis of volatility in financial time series to predicting the spread of coronavirus.

Participants are expected to have taken an introductory course in econometrics or time series analysis.

The recently published *Dynamic models for volatility and heavy tails* is primarily concerned with the topics in financial econometrics covered in the second day. It will be of particular interest to researchers who work in this area.

Some of the time series theory may be found challenging, but the lectures will stress the concepts and the implications for applied work.

Course outline

Day One

- 1 Introduction. Stationary time series. Unobserved components and signal extraction.
2. Time Series Models. ARIMA models. Structural time series models. Explanatory variables and intervention analysis.
3. STAMP package.
4. State space models and the Kalman filter. Signal extraction. Missing observations and other data irregularities.
5. Trends and cycles. Seasonality. Detrending and differencing. Multivariate time series models. Common trends and co-integration; control groups.

Day Two

1. Nonlinear models and financial econometrics.
2. Dynamic conditional score models. The TSL program.
3. Modelling volatility: EGARCH, time-varying correlation and association.
4. Further applications

Main Texts

* Commandeur, J.J.F. and S.J. Koopman. *An introduction to state space time series analysis*. OUP, 2007.

Durbin, J. and S.J. Koopman, *Time Series Analysis by State Space Methods*, 2nd ed. Oxford University Press, Oxford, 2012.

Harvey, A. C. *Dynamic Models for Volatility and Heavy Tails*. Cambridge University Press, 2013.

* Harvey, A. C., *Time Series Models (TSM)*, 2nd Edition, Harvester Wheatsheaf, 1993. [Currently out of print, 3rd edition in preparation]

Harvey, A. C. (2021) *Score-driven time series models*. Score-driven time series models. Annual Review of Statistics and Its Application, 94. (to appear) doi: 10.1146/annurev-statistics-040120-021023. CWPE 2133.

Harvey, A. (2021) Time Series Models for Epidemics: Leading Indicators, Control Groups and Policy Assessment. National Institute Economic Review (to appear). CWPE 2114.

Martin, V., Hurn, S. and D. Harris, (MHH) *Econometric Modelling with Time Series: Specification, Estimation and Testing*, 2013.

Taylor, S. *Asset Price Dynamics, Volatility, and Prediction*. Princeton University Press, 2005.

* Taylor, S. *Modelling Financial Time Series*, 2nd edition. World Scientific, 2008.

* Recommended for preliminary reading

Other references

Andersen, T.G., Bollerslev, T., Christoffersen, P.F. and F.X. Diebold. (2006). Volatility and correlation forecasting. *Handbook of Economic Forecasting*, edited by G Elliot, C Granger and A Timmermann, 777-878. North Holland.

Creal, D., Koopman, S.J., and A. Lucas (2013). Generalized autoregressive score models with applications. *Journal of Applied Econometrics*, 28, 777-795.

Franke, J., Hardle, W.K., Hafner, C.M., *Statistics of Financial Markets*, Third Edition, Springer, 2011.

Harvey, A. C., *Forecasting, Structural Time Series Models and the Kalman Filter (FSK)*, Cambridge University Press, 1989

Harvey, A.C., (2006). Forecasting with Unobserved Components Time Series Models, *Handbook of Economic Forecasting*, edited by G Elliot, C Granger and A Timmermann, 327-412. North Holland.

Hautsch, N. *Econometrics of Financial High-Frequency Data*, Berlin: Springer Verlag, 2012.

Mills, T. and R.N. Markellos, *The Econometric Modelling of Financial Time Series*, 3rd ed. Cambridge University Press, 2008

Tsay, R, *Analysis of Financial Time Series*, 3rd ed. Wiley, 2010.