TIME SERIES ECONOMETRICS

Fall semester, 2020–2021

Course information

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Course description

This course represents the first half of the two-semester sequence *Time series and financial econometrics*, and covers important aspects of modern time series econometrics. After reviewing of (or getting acquainted with) basic time series notions like stationarity, Wold decomposition, etc., we will discuss principles of non-structural time series modeling and review various model selection procedures. After that we will study popular models of conditional mean dynamics such as linear autoregressions and vector autoregressions as well as nonlinear structures like threshold, smooth transition and regime switching models. We will also explore such issues as stationarity vs integratedness and unit roots, and get acquainted with the notion of Brownian motion useful in other contexts as well. Then we will turn to modeling conditional variance and, more generally, volatility. We will also review modeling and forecasting other conditional objects such as conditional quantiles, probabilities, and densities. Finally, we will study methods of dealing with structural instability.

Course requirements, grading, and attendance policies

- The course presumes reading of textbooks and publications, as well as practical computer work with real data.
- There will be weekly home assignments combining theoretical exercises and empirical practice (20% of the course grade).
- One will need programming econometric software to do empirical exercises. MATLAB is recommended as a baseline, but GAUSS, Python and/or R are also options whenever appropriate.
- One may do empirics using low-level programming and get up to the exercise's full credit (and master the techniques), or, alternatively, utilize embedded high-level commands/libraries and get up to 25% of the exercise's full credit (and most likely not learn relevant techniques).

- There will be a presentation/mini-lecture (30-40 minutes) on a particular topic assigned far in advance (10% of the course grade).
- There will be a midterm exam (30% of the grade) and a final exam (40% of the grade).
- All the above components are mandatory (two home assignments are excused – for this count but not for the score) for getting a passing grade.
- Discussion sections will be devoted to solving problems and discussing relevant (both theoretical and applied) literature. Active participation in discussion sections will be awarded by up to bonus 10% of the course grade.

Course contents

I. Basics of time series analysis

- Stationarity and ergodicity. Linear processes. Lag operator.
- Innovations and Wold decomposition. AR, MA, ARMA, ARIMA. Box-Jenking methodology.
- Trend stationarity and difference stationarity.
- Nonlinear processes. Processes with time-varying parameters.

II. Modeling methodology and model selection

- Structural and non-structural time series modeling.
- Object of dynamic modeling: conditional mean, conditional variance, conditional quantile, conditional direction, conditional density.
- Model selection: diagnostic testing, information criteria and prediction criteria. Model confidence sets.
- General-to-specific and specific-to-general methodologies. Data mining.
- Predictability and testing for predictability.

III. Modeling conditional mean

- Stationary AR models: properties, estimation, inference, forecasting.
- Stochastic and deterministic trends, unit root testing. Brownian motion, FCLT.
- Nonlinear autoregressions: threshold autoregressions, smooth transition autoregressions, Markov switching models, state-space models.
- Stationary VAR models: properties, estimation, analysis and forecasting. Nonlinear VAR.
- Spurious regression, cointegrating regression, and their asymptotics. Engle-Granger test.

IV. Modeling conditional variance and volatility

- The class of ARCH models: properties, estimation, inference and forecasting.
- Extensions: IGARCH, ARCH-t. Time-varying risk and ARCH-in-mean.
- Multivariate GARCH: vech, BEKK, CCC, DCC, DECO. Variance targeting.
- Other measures of financial volatility: RiskMetrics, ranges, realized volatility.
- MEM models for RV and ranges. HAR models for RV. Models for jumps.

V. Other topics on modeling and forecasting

- Ultra-high frequency data models: ACD, UHF–GARCH.
- Modeling and forecasting conditional density. ARCD modeling.
- Multivariate dynamic densities. Copula machinery.
- Modeling and forecasting direction-of-change. Directional predictability.
- Modeling and forecasting conditional quantiles. Value-at-risk. CAViaR model.
- Generalized autoregressive score models. MIDAS models.

V. Analysis of structural stability

- Identification, estimation and testing for structural breaks. Andrews and Bai-Perron tests.
- Retrospection and monitoring for structural stability. CUSUM and other sequential tests.

Course materials

Textbooks

- Hamilton, James (1994). *Time Series Analysis*, Princeton University Press, selected chapters
- Franses, Philip and Dick van Dijk (2000). *Nonlinear Time Series Models in Empirical Finance*, Cambridge University Press, chapters 1–4
- Tsay, Ruey (2005). *Analysis of Financial Time Series*, John Wiley & Sons, chapters 1–5, 7–8, 10

Additional materials

A number of methodological materials and published journal articles will be assigned for reading.

Academic integrity policy

Cheating, plagiarism, and any other violations of academic ethics at CERGE-EI are not tolerated.