Economics 883 Tim Bollerslev
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919-660-1846

Econometrics for Financial and Macroeconomic Time Series

Overview: The specification, estimation, and diagnostic testing of dynamic models for economic and financial time series present a host of unique challenges, in turn requiring the use of specialized statistical models and inference procedures. This course provides a selective overview of some of the most important of these procedures. The discussion will be focused on the practical implementation of the different techniques, including specific applications in both macroeconomics and asset pricing finance, rather than formal proofs and theorems.

Requirements: I will assume that you have an understanding of econometrics and basic statistics at the level of first-year graduate econometrics, equivalent to Econ.703D (341D) and Econ.707D (342D) at Duke.

Class Schedule: Lectures will be held in Room 105, Tuesdays and Thursdays, 1:25-2:40pm.

Office Hours: My office hours are Wednesdays, 10:00-11:30am in Room 313.

Webpage: http://www.econ.duke.edu/~boller/Econ.883

Evaluation: Your grade for the course will be based on an equal weighting of your performance on the final exam and four problem sets. Then final exam will be on Tuesday, April 30, 1:25-3:25pm. You are encouraged to work on the problem sets in teams of up to four people. If you do work in a team, each team should hand in only one solution to the assignment. I may also consider your participation in the classroom discussions when determining your final grade for the course.

Books: The main textbook for the course is:

James D. Hamilton (1994). *Time Series Analysis*. Princeton, NJ: Princeton University Press. (This is a classic. It provides an exceptionally detailed and comprehensive discussion of the most important ideas in time series econometrics as of ~twenty years ago. Parts of the discussion are a bit dated by now. It is a great general reference book, however.)

Other useful textbooks:

Theodore W. Anderson (1971). *The Statistical Analysis of Time Series*. John Wiley & Sons, Inc. (Another classic book laid the foundation for many of the subsequent theoretical developments.)

Torben G. Andersen, Tim Bollerslev, Peter Christoffersen, and Francis X. Diebold (201?). *Volatility and Correlation: Practical Methods for Financial Applications*. Princeton University Press. (Keep looking, this is going to be a great book ...)

George E.P. Box and Gwilym M. Jenkins (1969). *Time Series: Forecasting and Control*. Holden-Day Inc. (*The* classical book on time series analysis that really started the field.)

Peter J. Brockwell and Richard A. Davis (2006). *Time Series: Theory and Methods, 2nd Ed*. Springer-Verlag. (An excellent more rigorous introduction to traditional time series analysis.)

Walter Enders (2009). *Applied Econometric Time Series, Second Edition, 3rd Ed*. John Wiley & Sons, Inc. (An intuitive applications oriented general discussion of time series econometrics.)

Christian Gourieroux and Joann Jasiak (2001). *Financial Econometrics*. Princeton University Press. (The first part of this book contains a good all-around survey of time series econometrics.)

Clive W.J. Granger and Paul Newbold (1977). *Forecasting Economic Time Series*. Academic Press. (Another classic in the field.)

Andrew C. Harvey (1990). *Econometric Analysis of Time Series, 2nd Ed*. MIT Press (First published more than two decades ago, it is still a good reference for many of the basic topics.)

Eric Jondeau, Ser-Huang Poon and Michael Rockinger (2007). *Financial Modeling Under Non-Gaussian Distributions*. Springer-Verlag. (A nice up-to-date discussion of applied financial time series econometrics.)

Maurice B. Priestley (1981). *Spectral Analysis and Time Series*. Academic Press. (The classical textbook treatment of spectral analysis.)

Stephen J. Taylor (2005). *Asset Price Dynamics, Volatility, and Prediction*. Princeton University Press. (A very nice applications oriented summary of different time series procedures and techniques, with an emphasis on uses in empirical finance and volatility modeling.)

Ruey S. Tsay (2005). *Analysis of Financial Time Series, 2nd Ed*. John Wiley & Sons, Inc. (A very readable textbook, focusing primarily on the techniques used in financial time series econometrics.)

Course Outline and Readings:

In addition to the relevant chapters in the book by Hamilton, we will also discuss several journal articles and Handbook chapters. The papers that we will cover in some detail are marked with a (*) below. In general, however, I will mostly rely on my own notes and interpretation.

1. Univariate Stationary ARMA Models

(*) Hamilton, Chapters 3, 4.

Hamilton, Chapters 1, 2 (this is review material about difference equations and lag operators).

Anderson, Chapters 5-7.
Box and Jenkins, Chapters 1-9.
Brockwell and Davis, Chapters 1, 3, 5, 7, and 9.
Enders, Chapters 1, 2.
Taylor, Chapter 3.
Tsay, Chapter 2.

2. MLE and QMLE

(*) Hamilton, Chapter 5.

(*) Tim Bollerslev and Jeffrey M. Wooldridge (1992), "Quasi-Maximum Likelihood Estimation and Inference in Dynamic Models with Time Varying Covariances," *Econometric Reviews* 11, 143-172.

Brockwell and Davis, Chapter 8.
Harvey, Chapters 3-4.

3. Hypothesis Testing and Model Selection

(*) Robert F. Engle (1986), "Wald, Likelihood Ratio, and Lagrange Multiplier Tests in Econometrics," Chapter 13 in *Handbook of Econometrics*, Vol.2, (Zvi Griliches and Michael D. Intriligator, eds.). Amsterdam: Elsevier Science B.V..

(*) John Geweke and Richard Meese (1981), "Estimating Regression Models of Finite but Unknown Order," *International Economic Review* 22, 55-70.

Hamilton, Chapter 5.

4. Spectral Analysis and Filtering

(*) Hamilton, Chapter 6 and Sections 10.4-10.5.

(*) Marianne Baxter and Robert G. King (1999), "Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series," *Review of Economics and Statistics* 81, 575-593.

(*) Robert F. Engle (1976), "Interpreting Spectral Analysis in Terms of Time Domain Models," *Annals of Economic and Social Measurement* 5, 89-109.

Anderson, Chapters 8-9.
Brockwell and Davis, Chapters 4, 10, and Sections 11.6-11.8.
Priestley, Chapters 1, 4-11.

5. Vector Autoregressions

(*) Hamilton, Sections 10.1-10.3 and Chapter 11.

(*) James H. Stock and Mark W. Watson (2001), "Vector Autoregressions," *Journal of Economic Perspectives* 15, 101-115.

(*) Mark W. Watson (1994), "Vector Autoregressions and Cointegration," Section 4, Chapter 47 in *Handbook of Econometrics*, Vol.4, (Robert F. Engle and Daniel McFadden, eds.). Amsterdam: Elsevier Science B.V..

Enders, Chapter 5.
Gourieroux and Jasiak, Chapters 3, 4.
Tsay, Chapter 8.

6. GMM and Simulated Methods of Moments

(*) Lars P. Hansen and Kenneth J. Singleton (1982), "Generalized Instrumental Variables Estimation of Non-Linear Rational Expectations Models," *Econometrica* 50, 1269-86, "Errata," *Econometrica* 52, 267-268.

George Tauchen and A. Ronald Gallant (1996), "Which Moments to Match?," *Econometric Theory* 12, 657-681.

Hamilton, Chapter 14.

7. Unit Roots

(*) Hamilton, Chapters 15-18.

Hamilton Chapter 7 (contains review material on standard asymptotic distribution theory for stationary processes).

James H. Stock (1994), "Unit Roots, Structural Breaks and Trends," Chapter 46 in *Handbook of Econometrics*, Vol.4, (Robert F. Engle and Daniel McFadden, eds.). Amsterdam: Elsevier Science B.V..

8. Cointegration

(*) Hamilton, Chapters 19-20.

"Time-Series Econometrics: Cointegration and Autoregressive Conditional Heteroskedasticity," *Advanced Information on the 2003 Nobel Prize in Economic Sciences*.

Phillips, P.C.B. (1986), "Understanding Spurious Regressions in Econometrics," *Journal of Econometrics* 33, 311-340.

Mark W. Watson (1994), "Vector Autoregressions and Cointegration," Section 3, Chapter 47 in *Handbook of Econometrics*, Vol.4, (Robert F. Engle and Daniel McFadden, eds.). Amsterdam: Elsevier Science B.V..

Enders, Chapter 6.

9. Long-Memory and Fractional Differencing

(*) Richard T. Baillie (1996), "Long-Memory Processes and Fractional Integration in Econometrics," *Journal of Econometrics* 73, 5-59.

Richard T. Baillie, Tim Bollerslev and Hans O. Mikkelsen (1996), "Fractionally Integrated Generalized Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics* 74, 3-30.

Tim Bollerslev, Daniela Osterrieder, Natalia Sizova, and George Tauchen (2011), "Risk and Return: Long-Run Relationships, Fractional Cointegration, and Return Predictability," unpublished manuscript.

Tsay, W.-J., and C.-F. Chung (2000), "The Spurious Regression of Fractionally Integrated Processes," *Journal of Econometrics* 96, 155-182.

10. Time-Varying Volatility

(*) Torben G. Andersen, Tim Bollerslev, Peter Christoffersen and Francis X. Diebold (2013), "Financial Risk Measurement for Financial Risk Management," in *Handbook of the Economics of Finance* (George Constantinides, Milton Harris and Rene Stulz, eds.). Amsterdam: Elsevier Science B.V.

Torben G. Andersen, Tim Bollerslev and Francis X. Diebold (2010), "Parametric and Nonparametric Volatility Measurement," Chapter 2 in *Handbook of Financial Econometrics* (Yacine AïtSahalia and Lars P. Hansen, eds.). Amsterdam: Elsevier Science B.V.

(*) Torben G. Andersen, Tim Bollerslev, Peter Christoffersen and Francis X. Diebold (2006), "Volatility and Correlation Forecasting," Chapter 15 in *Handbook of Economic Forecasting* (Graham Elliott, Clive W.J. Granger and Allan Timmermann, eds.). Amsterdam: Elsevier Science B.V..

Tim Bollerslev, Robert F. Engle and Daniel B. Nelson (1994), "ARCH Models," Chapter 49 in *Handbook of Econometrics*, Vol.4, (Robert F. Engle and Daniel McFadden, eds.). Amsterdam: Elsevier Science B.V..

"Time-Series Econometrics: Cointegration and Autoregressive Conditional Heteroskedasticity," Information on the 2003 Nobel Prize in Economic Sciences, Available at: *http://www.nobel.se/economics/laureates/2003/ecoadv.pdf*

Tim Bollerslev, Ray Chou and Kenneth F. Kroner (1992), "ARCH Modeling in Finance: A Review of the Theory and Empirical Evidence," *Journal of Econometrics* 52, 5-59.

Enders, Chapter 3.
Hamilton, Chapter 21.
Jondeau, Poon and Rockinger, Chapters 4-6.
Gourieroux and Jasiak, Chapter 6.
Taylor, Chapters 8-12.
Tsay, Chapters 3 and 9.