Dept. of Economics
UNC

Spring 2014

Economics 871
Time Series Analysis

Prof. Jonathan B. Hill

Jonathan Hill
GA 208B
jbhill@email.unc.edu

Time and Place
Mon & Wed. 10:30am-11:45am
GA 007

Office Hours
M,W 9:30-10:30am

Prerequisites
1. Economics 770 (Introduction to Econometric Theory)
2. Economics 771 (Econometrics)
3. Graduate level probability theory and mathematical statistics (usually obtained through 1 and 2).

Objectives
This course is concerned with modeling information over time from statistical, mathematical and economic perspectives. Economic information over time exhibits stylized characteristics: 1. *persistence*: values today are weakly-to-highly dependent on values in the near-to-distant past (e.g. output, investment, equity returns); 2. *nonlinearity*: the relationship between economic variables over time is often nonlinear based on forecasting principles and/or economic rational (e.g. exchange rates); 3. *heterogeneity* and *non-stationarity*: attributes of economic events evolve or suddenly change over time (e.g. output; shock to investment trend); 4. *conditional heteroscedasticity*: volatility in macroeconomic and financial variates cluster (e.g. equity returns); 5. *leptokurtosis*: many economic time series have too many large values to be modeled by a Gaussian distribution, and many suggest extremely heavy distribution tails (infinite fourth or even second moment: asset returns).

All of these properties alone, or in combination, imply standard modeling and estimation techniques, and accompanying large sample theory, are either more difficult to verify, or simply do not apply. We begin by studying formal concepts of memory, from the very abstract (mixing, regularity, ergodocity, near-epoch-dependence) to more concrete notions (autocovariance). We will use the concrete concepts (autocovariance) to construct linear and nonlinear parametric time series models (Autoregressive Moving Averages:ARMA, Vector Autoregression: VAR, Generalized Autoregressive Conditional Heteroscedasticity: GARCH), and use the abstract concepts to analyze the small and large sample properties of parameter estimators (Ordinary Least Squares, Nonlinear Least Squares, Quasi-Maximum Likelihood).

Evaluation
There will be one midterm exam (30%), a final exam (40%), and an assortment of assignments based on econometric theory and computer applications (30%). While students may consult with each other, each must turn in his or her own work.

Reading and Textbooks

Required Reading

Time Series Analysis by J. D. Hamilton, 1994, Princeton University Press.

Suggested Reading

Time Series: Theory and Methods, by P. J. Brockwell and R. Davis (1991), Springer Verlag.
Introduction to Multiple Time Series Analysis by Helmut Lutkepohl (1991), Springer Verlag.
Forecasting by M.P. Clements and D.F. Hendry (2000), Cambridge Univ. Press.
Analysis of Financial Time Series by R. Tsay (2002), Wiley.
ARCH Models and Financial Applications by C. Gourieroux (1997), Springer.
The Econometric Modeling of Financial Time Series by T.C. Mills (1996), Cambridge.
Stochastic Limit Theory, by James Davidson (1994), Cambridge University Press.
Asymptotic Theory for Econometricians by Halbert White (1999), Academic Press.
Asymptotic Theory of Statistic Inference for Time Series by M. Taniguchi and Y. Kakizawa (2000).
Financial Modeling under Non-Gaussian Distributions by E. Jondeau, S-H.Poon, M. Rockinger (2006).

Topics (*these many change during the course of the semester***)**	**Readings**[1]
1. Stationarity, ergodicity, dependence concepts, limit theory for linear processes	L*; D* 1, 13; B 1 W 2[2]
2. Autocorrelation function: theory, estimation, asymptotics, inference.	**H 3, 7**; **P #1,2**; B 3, 7
3. Stationary ARMA: representation, spectrum, QML estimation, forecasting, asymptotic theory	**H 1-5, 7, 14**; **P #3** B 8; D 13-20, 23-24, CH all.
4. Spectral analysis (time and frequency domain decompositions)	**H 6**; B 4
5. Kalman Filter - State Space representations, ARMA	**H 13**
6. Regression Models with Dependent Regressors (ARX, NLARX)	**H 8**; **P #4-6**; W 3, 5
7. Model specification testing: martingale difference hypothesis, linearity.	**P #7-9, 21**; B 9
8. Non-Stationarity: Trend, Unit Roots, Cointegration	**H 15-17, 19; P #10-12**
9. Random volatility models: mixtures, GARCH, FIGARCH	**H 21, G; P #13-19**
10. Vector Autoregressions: estimation, asymptotic theory, cointegration.	**H 11; Papers #20,21**

[1] Readings from Hamilton (**H**) and journal papers (**P**) are mandatory. * = highly recommended. All other suggested readings are based on the bibliography above. Use Davidson and White to guide your reading of the theoretical concepts developed in the lecture notes, but keep in mind that the lecture notes are merely a sketch of some ideas.
[2] H = Hamilton (required reading); P = papers (required reading); L = lecture notes (suggested); D = Davidson; W = White; B = Brockwell and Davis; CH = Clements and Hendry (forecasting); G = Gourieroux.

Journal Papers

1. Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series Models by G.E.P. Box and D.A. Pierce *Journal of the American Statistical Association*, 65 (1970), pp. 1509-1526.
2. The Asymptotic Distribution of Serial Covariances by E.J. Hannan, *Annals of Statistics* 4, pp. 396-399.
3. Macroeconomic Forecasting Using Pooled International Data by S. Mittnik, *Journal of Business & Economic Statistics* 8 (1990), pp. 205-208.
4. National Savings and Budgets by R. Eisner, *Review and Economics and Statistics* 76 (1994), pp. 181-186
5. Predictions From ARMAX Models., by R. Baillie, *Journal of Econometrics* 12 (1980), pp. 365--374.
6. ARMAX Model Specification Testing, with an Application to Unemployment in the Netherlands by H.J. Bierens, *Journal of Econometrics* 35 (1987), pp. 161-190.
7. Nonlinear Time-Series Analysis of Stock Volatilities by C.Q. Rao and R.S.Tsay, *Journal of Applied Econometrics* 7 (1992), pp. S165-S185.
8. A Consistent Conditional Moment Test of Functional Form, by H.J. Bierens, *Econometrica* 58 (1990), pp. 1443-1458.
9. Inference When a Nuisance Parameter Is Not Identified Under the Null Hypothesis, by. B. Hansen, *Econometrica* 64 (1996), pp. 413-430.
10. Time Series Regression with a Unit Root by P.C.B. Phillips, *Econometrica* 55 (1987), pp. 277-301.
11. Co-Integration and Error Correction: Representation, Estimation, and Testing by R. Engle and C. Granger, *Econometrica* 55 (1987), pp. 251-276.
12. Some Properties of Time Series Data and Their Use in Econometric Model Specification by C. Granger, *Journal of Econometrics* 16 (1981), pp. 121-130.
13. A Subordinated Stochastic Process Model with Finite Variance for Speculative Prices by P.K. Clark, *Econometrica* 51 (1973), pp. 135-155.
14. Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation by E. Engle, *Econometrica* 50 (1982), pp. 987-1007.
15. Generalized Autoregressive Conditional Heteroskedasticity, by T. Bollerslev, *Journal of Economics* 31, (1986), pp. 307-327
16. ARCH Models, by R. Engle, D. Nelson and T. Bollerslev, in *Handbook of Econometrics*, Volume IV, ed. R. Engle and D. McFadden (Amsterdam: North Holland, 1994), 2959-3038.
17. New Frontiers in ARCH Models, by R. Engle, *Journal of Applied Econometrics*, (2002): 425-446, V17N2
18. Nonlinear Features of Realized FX Volatility *b*y J.M. Maheu; T.H. McCurdy, *The Review of Economics and Statistics*, 84 (2002), pp. 668-681.
19. Fractionally Integrated GARCH by R.T. Baillie, T. Bollerslev and H.O. Mikkelsen, *Journal of Econometrics* 74 (1996) pp. 3-30.
20. Short Run and Long Run Causality in Time Series: Theory by J.M. Dufour and E. Renault, *Econometrica* 66 (1998), pp. 1099-1125.
21. Long-Run Neutrality and Superneutrality in an ARIMA Framework by M.E. Fisher and J.T. Seater, *American Economic Review* 83 (1993), pp. 402-415.