ECON 673: Time Series Econometrics

Professor Mohitosh Kejriwal

Fall 2016

Lectures: Mondays and Wednesdays, 4:30-6:00pm in RAWLS 2079

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Course Overview: This course examines the models and statistical techniques used in the analysis of time series data in economics. Such data are extensively used in the fields of macroeconomics, international economics and financial economics. The course has two specific objectives. The first is to equip students with the main statistical tools required for conducting state-of-the-art empirical research using time series data. The second objective is to lay out the econometric theory of time series analysis, with an emphasis on recent developments. Upon finishing the course, students should be able to appreciate the main issues of interest in the field as well as be able to study the recent literature as published in the leading journals. Knowledge of a matrix oriented programming language (such as MATLAB) is useful although a software package such as STATA would suffice for implementing the methods covered in this course.

Prerequisites: ECON 670-672 or equivalent.

Problem Sets: Problem sets will be assigned on a regular basis. You may work in groups (not exceeding 3 people) on the problem sets. Please turn in only one copy per group (be sure to write each group member's name on it). Some problem sets will be theoretical while others will include a mix of theory and empirical problems.

Grading: The evaluation for the course will be based on problem sets (20%), a midterm exam (30%) and a final exam (50%). The midterm will be held **during the week of**

November 14-18. The final exam will be held during university final exam week (time and place TBD). Please note that the final exam is cumulative and will be based on all material that will be covered during the course.

Course Website: All material related to the course will be available through Blackboard. You will need to log in with your Purdue username and password.

Textbooks and Lecture Notes: The recommended textbook for the course is Hamilton, J.D. (1994), *Time Series Analysis,* Princeton University Press. Two other books that are more application oriented are: (1) Enders, W. (2010), *Applied Econometric Time Series,* Third Edition, Wiley. (2) Lütkepohl, H. & Krätzig, M. (2004), *Applied Time Series Econometrics,* Cambridge University Press. I will additionally provide a set of lecture notes for each topic covered in class.

Other Suggested References:

1. Brockwell, P.J. & Davis, R.A., *Time Series: Theory and Methods,* Springer.
2. Davidson, J., *Stochastic Limit Theory,* Oxford University Press.
3. Davidson, R. & MacKinnon, J.G., *Econometric Theory and Methods,* Oxford University Press.
4. Harvey, A.C., *Forecasting, Structural Time Series Models and the Kalman Filter,* Cambridge University Press.
5. Lütkepohl, H., *New Introduction to Multiple Time Series Analysis,* Springer.
6. Tsay, R.S., *Analysis of Financial Time Series*, Third Edition, Wiley.
7. White, H., *Asymptotic Theory for Econometricians,* Academic Press.

Emergency: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances.

Course Outline and Suggested Readings [* denotes primary reading]

Part I: Stationary Time Series Models

- Univariate Time Series: Concepts of stationarity and ergodicity, ARMA processes, principles of forecasting, estimation in the time domain.

References:

1. *Hamilton, Ch 3-5.

2. Enders, Ch 2.

3. Lütkepohl & Krätzig, Ch 2.

- Multivariate Time Series: identification, estimation and inference using vector autoregressive processes (VARs), causality tests, impulse response function, variance decomposition.

References:

1. *Hamilton, Ch 10-11.

2. Enders, Ch 5.

3. *Lütkepohl & Krätzig, Ch 3-4.

4. Blanchard, O.J. & Quah, D. (1989), The Dynamic Effects of Aggregate Demand and Supply Disturbances, American Economic Review 79, 655-673.

5. Cooley, T. & Dwyer, M. (1998), Business Cycle Analysis without Much Theory: a Look at Structural VARs, Journal of Econometrics 83, 57-88.

6. Granger, C.W.J. (1969), Investigating Causal Relations by Econometric Models and Cross-spectral Methods, Econometrica 37, 424-438.

7. Shapiro, M. & Watson, M. (1988), Sources of Business Cycle Fluctuations, NBER Macroeconomics Annual 3, 111-147.

8. *Stock, J.H. & Watson, M.W. (1999), Business Cycle Fluctuations in U.S. Macroeconomic Time Series, in Handbook of Macroeconomics Vol. 1a, 3-64.

9. *Sims, C.A. (1980), Macroeconomics and Reality, Econometrica 48, 1-48.

Part II: Nonstationary Time Series Models

- The Functional Central Limit Theorem

References:

1. Hamilton, Ch 17.

2. Davidson, J. (1994), *Stochastic Limit Theory,* Oxford University Press.

- Trends and Unit Roots: Estimation with deterministic time trends, comparison of trend stationary and unit root processes, approaches to testing for a unit root.

1. *Hamilton, Ch 17.

2. Enders, Ch 4.

3. Lütkepohl & Krätzig, Ch 2.

4. *Campbell, J. Y. & Perron, P. (1991), Pitfalls and Opportunities: What Macroeconomists should know about Unit Roots, NBER Macroeconomic Annual 6, 141-201.

5. Dickey, D.A. & Fuller, W.A. (1979), Distribution of the Estimators for Autoregressive Time Series With a Unit Root, Journal of the American Statistical Association 74, 427-431.

6. *Elliott, G., Rothenberg, T.J. & Stock, J.H., (1996), Efficient Tests for an Autoregressive Unit Root, Econometrica 64, 813-836.

7. *Nelson, C.R. & Plosser, C.I. (1982), Trends and Random Walks in Macroeconomic Time Series, Journal of Monetary Economics 139-162.

8. *Ng, S. & Perron, P. (2001), Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power, Econometrica 6, 1519-1554.

9. Stock, J.H. (1994), Unit Roots, Structural Breaks and Trends, Handbook of Econometrics vol IV, chapter 46.

- Cointegration and Error Correction: Estimation of vector error correction models, impulse response analysis, forecasting in cointegrated systems, testing for cointegrating rank.

References:

1. *Hamilton, Ch 18-20.

2. Enders, Ch 6.

3. *Lütkepohl & Krätzig, Ch 3-4.

4. Elliott, G. (1998), The Robustness of Efficient Cointegration Estimators when Regressors Almost Have Unit Roots, Econometrica 66, 149-158.

5. *Engle, Robert F. & Granger, C.W.J. (1987), Co-Integration and Error Correction: Representation, Estimation and Testing, Econometrica 55, 251-276.

6. Haug, A. (1996), Tests for Cointegration: A Monte Carlo Comparison, Journal of Econometrics 71, 89-115.

7. Jansson, M and Moreira, M. (2006), Optimal Inference in Regression Models with Nearly Integrated Regressors, Econometrica 74, 681-714.

8. King, R. G., Plosser, C.I., Stock, J.H. & Watson, M.W. (1991), Stochastic Trends and Economic Fluctuations, American Economic Review 81, 819-840.

9. *Watson, M (1994), Vector Autoregressions and Cointegration, Handbook of Econometrics vol IV, chapter 47.

Part III: Selected Topics

- Structural Breaks: detection and estimation of structural breaks in time series data, interplay between structural change and unit roots, forecasting in the potential presence of breaks.

References:

1. *Enders, Ch 4.
2. *Andrews, D.W.K. (1993), Tests for parameter instability and structural change with unknown change point, Econometrica 61, 821-856.
3. Bai, J. (1997), Estimation of a change point in multiple regression models, Review of Economics and Statistics 79, 551-563.
4. Bai, J., Lumsdaine, R.L. & Stock, J.H. (1998), Testing for and Dating Common Breaks in Multivariate Time Series, Review of Economic Studies 63, 395-432.
5. *Bai, J. & Perron, P. (1998), Estimating and Testing Linear Models with Multiple Structural Changes, Econometrica 66, 47-78.
6. Hansen, B. (2001), The New Econometrics of Structural Change: Dating Changes in U.S. Labor Productivity, Journal of Economic Perspectives 15, 117-128.
7. *Perron, P. (2006), Dealing with structural breaks, in Palgrave Handbook of Econometrics, Palgrave Macmillan, 278-352.
8. Stock, J.H. & Watson, M.W. (1996), Evidence on Structural Instability in Macroeconomic Time Series Relations, Journal of Business & Economic Statistics 14, 11-30.

- Volatility Modeling: Estimation, inference and prediction using ARCH, GARCH and stochastic volatility models, comparison of forecast performance using alternative models, predictive regression analysis.

References:

1. Andersen, T.G. & Bollerslev, T. (1998), Answering the skeptics: yes, standard volatility models provide accurate forecasts, International Economic Review 39, 885-905.
2. *Bollerslev, T. (1986), Generalized autoregressive conditional heteroskedasticity, Journal of Econometrics 31, 307-327.
3. *Engle, R.F. (1982), Autoregressive conditional heteroskedasticity with estimates of the variance of UK inflation, Econometrica 50, 987-1007.

4. Hansen, P. & Lunde, A. (2005), A forecast comparison of volatility models: does anything beat a GARCH(1,1)?, Journal of Applied Econometrics 20, 873-889.

5. Nelson, D. (1991), Conditional heteroskedasticity in asset returns: a new approach, Econometrica 59, 347-370.

6. Teräsvirta, T. (2009), An introduction to univariate GARCH models, in Handbook of Financial Time Series, Springer.

7. Tsay, R.S. (2010), *Analysis of Financial Time Series*, Third Edition, Wiley (Ch 3).

8. *Zivot, E. (2009), Practical issues in the analysis of univariate GARCH models, in Handbook of Financial Time Series, Springer.

- Unobserved Components Models: state space modeling, Kalman Filter, maximum likelihood estimation and the prediction error decomposition.

1. *Hamilton, Ch 13, 22.

2. *Hamilton, J.D. (1989), A New Approach to the economic Analysis of Nonstationary Time Series and the Business Cycle, Econometrica 57, 357-384.

3. *Harvey, A.C. (1989), *Forecasting, Structural Time Series Models and the Kalman Filter,* Cambridge University Press (Ch 3-5).

4. Durbin, J. & Koopman, S.J. (1997), Monte Carlo Maximum Likelihood Estimation for Non-Gaussian State Space Models, Biometrika 84, 669-684.

5. Kitagawa, G. (1987), Non-Gaussian State Space Modelling of Non-Stationary Time Series with discussion, Journal of the American Statistical Association 82, 1032-1063.

6. Perron, P & Wada, T. (2009), Let's Take a Break: Trends and Cycles in US Real GDP, Journal of Monetary Economics 56, 749-765.