TIME SERIES ECONOMETRICS
ECON- 4521
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ESCUELA DE VERANO 2011

Fecha de inicio: 18 de Junio a 2 de Julio **(**Incluye sábados 18 y 25 de junio y 2 de julio)
Hora: 9:00 a.m. a 11:50 a.m.

Textbook: Hamilton, J. D. (1994) *Time Series Analysis*, Princeton University Press, New Jersey. I will follow Hamilton's book rather closely: On the syllabus the notation H* indicates which chapter corresponds to each topic. Regardless, this is a great book, worth having in your library. I will provide additional references for specific topics. Additional readings for each topic can be found at the end of this document**.**

Course Goals: The course is intended to fulfill two needs: (1) to provide students with applied interests with the most sophisticated and up to date techniques used in empirical time series analysis, and (2) to introduce students with more theoretical inclinations to the tools that are used to derive some of the more interesting results.

Material: The syllabus contains a long list of topics. Due to time constrains I might skip over some of points listed to be able to cover some of the more interesting and cutting edge topics that I think may help you in developing your thesis proposal.

Midterm Exam: ***You will have one take home midterm that will consist of two parts. An empirical part involving the software packages EViews and/or GAUSS, and a theoretical part. You will have to be relatively independent in learning the statistical packages. You are more than welcome to use any other statistical package you know keeping in mind that I may not be able to help you. I recommend you become familiar with Gauss as soon as possible. A great introduction is provided by Mark Watson at*** *http://www.wws.princeton.edu/~mwatson/ec518/gauss_tutorial.html*

Final Exam: You will have a take home final exam. It will be handed out on the last day of class (Saturday July 2nd) and will have to be turned in on Tuesday July 5nd).

Grading: There will be two components to your grade:
Midterm exam (50%)
Final exam (50%)

Course Outline:

TOPIC 1: INTRODUCTION TO UNIVARIATE, STATIONARY TIME SERIES (H2, H3)

- Introduction: cross-section vs. time-series
- Preliminary Concepts:
  - Lag Operators
  - White noise, martingales and martingale difference sequences
  - Autocovariances and autocorrelations

    - Stationarity:
        - Weak stationarity
        - Strong stationarity
    - Ergodicity and the Ergodic Theorem
    - Uniform-mixing and strong-mixing
- Modes of Convergence: convergence in probability, mean square, almost sure and convergence in distribution. (H7)
- Laws of Large Numbers:
- Central Limit Theorem/s:
- The Delta Method
- Basic ARMA models: (H3)
    - MA, AR, and ARMA models
    - Wold representation theorem

TOPIC 2: ESTIMATION, INFERENCE AND FORECASTING (H4, H5)

- The Method of Maximum Likelihood (H5)
    - Consistency
    - Asymptotic Normality
- MLE for ARMA models
    - AR ML: exact versus conditional likelihood
    - MA ML: exact versus conditional likelihood
    - ARMA ML
- Statistical Inference
    - Wald, Likelihood Ratio and Lagrange Multiplier principles
    - Liung-Box and Box-Pierce statistics.
- Forecasting (H4)
    - MSE and optimal forecasts
    - Updating rule
    - Forecasting with ARMA models
- Comparing Predictive Accuracy
    - Diebold and Mariano test for predictive accuracy

TOPIC 3: UNIT ROOTS (H15, H16, H17)

- Detrending Methods: deterministic vs. stochastic trends
- Asymptotic distribution of the simple trend model
- Unit Roots
    - Preliminaries: Brownian motion
    - Functional central limit theorem:
        - Convergence in law of random functions
        - Convergence in probability of random functions
        - Continuous mapping theorem
    - The Dickey-Fuller distribution
    - Functional central limit theorem for dependent processes
        - The augmented Dickey-Fuller test: derivation
        - The Phillips-Perron test: derivation

TOPIC 4: COVARIANCE STATIONARY VECTOR TIME SERIES (H10, H11)

- The VAR(p)
  - Presentation
  - Stationarity
  - Wold's theorem and the VMA representation
- Heteroskedasticity and Autocorrelation Variance Estimation
  - Newey-West estimator
- Granger causality and exogeneity
- MLE of vector processes
- Structural interpretation of VARs
  - The impulse response function
  - The variance decomposition
  - Identification and Interpretation
- Inference in VARs

TOPIC 5: GENERALIZED METHOD OF MOMENTS (H14)

- Introduction: classical method of moments
- GMM
  - Formulation
  - Optimal weighting matrix
  - Asymptotic distribution
  - Inference:
    - The J-statistic
    - Tests of subsets of orthogonality conditions
    - LR tests
  - MLE and GMM
    - Wald tests
    - LM tests
  - Extensions

TOPIC 6: COINTEGRATION (H19, H20)

- Motivation: spurious regressions
- Definition:
  - Properties
  - Error correction representation
  - Granger representation theorem
  - Phillips triangular representation
  - Stock-Watson common trends representation
- Testing
  - Engle-Granger 2-step cointegration test
    - Corrections for serial correlation
- Full Information Maximum Likelihood analysis of cointegrated systems
  - Preliminaries: canonical correlations
  - Johansen's test
  - Concentrating the likelihood
  - Hypothesis testing

TOPIC 7: TIME SERIES MODELS FOR HIGHER MOMENTS AND TRANSITION DATA (H21)

- ARCH models
  - Relation to ARMA
  - MLE – GARCH
  - Testing for ARCH
  - Extensions
- ACD models
  - Specification
  - Estimation
- ACH models (we may skip this)
  - Presentation
  - Relation to ACD
  - Estimation
- ACI models (we may skip this)
  - Presentation
  - Relation to ACD
  - Estimation

TOPIC 8: STATE SPACE MODELING AND THE KALMAN FILTER

- State Space Representation
- Kalman Filter
  - Overview
  - Algorithm
  - Forecasting
- MLE with the Kalman filter
- Asymptotic properties of MLE/QMLE

TOPIC 9: BOOTSTRAP METHODS IN ECONOMETRICS

- Introduction to Bootstrap
- Bootstrap for Time Series
  - Block Bootstrap
  - Non stationary Bootstrap
- Bootstrap with unit roots and cointegration

Additional Reading

Almost all the material for the class comes from Hamilton's book so you need not worry about the reading list except when indicated in class. The references contained in Hamilton's book are quite comprehensive if you ever need to go deeper into a topic. The references below might be helpful if you have difficulty understanding the material. A * indicates references I find particularly useful. Readings in bold indicate REQUIRED readings (no excuses!).

TOPIC 0: REVIEW OF PROBABILITY THEORY

- *Amemiya, T. (1985), Advanced Econometrics. Cambridge: Harvard University Press. (Chapter 3). [Amemiya]
- Davidson, James (1994) Stochastic Limit Theory, Oxford: Oxford University Press.

- Davidson, Russell and James G. Mackinnon (1993), Estimation and Inference in Econometrics. New York: Oxford University Press. (Chapter 4) [Davidson and Mackinnon]
- ***Hamilton, Chapter 7.**
- Hayashi, Fumio (2000) Econometrics. Princeton: Princeton University Press. (Chapter 2) [Hayashi]
- *White, Halbert (1999) Asymptotic Theory for Econometricians, Revised Edition. San Diego: Academic Press. Chapters 2-5

TOPIC 1: INTRODUCTION TO UNIVARIATE, STATIONARY TIME SERIES

- Box, G.E.P. and G.M. Jenkins (1976), *Time Series Analysis: Forecasting and Control*, 2nd ed. San Francisco: Holden Day.
- Gourieroux C. and A. Monfort (1997), *Time Series and Dynamic Models*. Cambridge: Cambridge University Press.
- ***Hamilton, Chapters 1-3.**
- *Sargent, T. J. (1987), *Macroeconomic Theory*. Boston: Academic Press. (Chapters 9-11).

TOPIC 2: ESTIMATION, INFERENCE AND FORECASTING

- *Amemiya, Chapter 4.
- Clements, Michael P. and David F. Hendry (1998) Forecasting Economic Time Series, Cambridge: Cambridge University Press.
- *Davidson, R. and J. G. MacKinnon, Chapter 8.
- *Engle, R. F. (1984), "Wald, Likelihood Ratio, and Lagrange Multiplier Tests in Econometrics," Ch. 13 in Handbook of Econometrics, Vol. II, eds. Z. Griliches and M.D. Intrilligator, Amsterdam: North-Holland.
- *Granger, C. W. J. and P. Newbold, (1986) Forecasting Economic Time Series. Academic Press.
- *Granger, C. W. J. and Timo Terasvirta (1993) Modelling Nonlinear Economic Relationships, Oxford: Oxford University Press, Chapter 8.
- *Greene, W. H. (1997) *Econometric Analysis, 4th Edition*. New Jersey: Prentice Hall. (Chapter 5).
- ***Hamilton, Chapters 4-5.**
- ***Diebold, F.X. (1998),** "The Past and Present of Macroeconomic Forecasting," *Journal of Economic Perspectives*, 12, 175-192.
- ***Diebold, F.X. and R.S. Mariano (1995),** "Comparing Predictive Accuracy," *Journal of Business and Economic Statistics*, 13, 253-265. Re-printed in *Journal of Business and Economic Statistics*, 20(1), 134-145, January 2002.
- Mark, N. (1995), "Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability," *American Economic Review*. Available in JSTOR.

TOPIC 3: UNIT ROOTS

- Brockwell, P.J. and R. A. Davis. Time Series: Theory and Methods. Springer-Verlag.
- * Davidson, J. (1994) Stochastic Limit Theory. Oxford; Oxford University Press.
- Dickey, D. A. and W. A. Fuller (1979), " Distribution Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, 74, 437-431.
- Fuller, W. A. Introduction to Statistical Time Series. Wiley series in Probability and Statistics. John Wiley.
- ***Hamilton, Chapters 15-17.**
- Phillips, P.C.B. (1986), "Time Series Regression with Unit Roots," *Econometrica*, 55, 227-302.
- Phillips, P.C.B. (1998), "New Tools for Understanding Spurious Regressions," *Econometrica*, 66, 1299-1236.
- ***Stock, J. H. (1994),** "Unit Roots, Structural Breaks, and Trends," *in Handbook of Econometrics*, Vol. IV, eds. D. McFadden and R. F. Engle. Amsterdam: North-Holland.
- * Tanaka, Katsuto, (1996) Time Series Analysis. New York: John Wiley (Chapter 3 and Chapter 9).

- Campbell, J. and G. Mankiw (1987), "Are Output Fluctuations Transitory," *Quarterly Journal of Economics.* Available in JSTOR.
- Clark. P.K. (1987), "The Cyclical Component of U.S. Economic Activity," *Quarterly Journal of Economics*. Available in JSTOR.
- Cochrane, J. (1988), "How Big is the Random Walk Component in GNP," *Journal of Political Economy*, No. 5. Available in JSTOR.
- ***Nelson, C.R. and C.I. Plosser (1982),** "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications," *Journal of Monetary Economics*, 10, 139-162.
- ***Stock, J.S. and M.Watson (1988),** "Variable Trends in Economic Time Series," *Journal of Economic Perspectives*, Vol 2, No. 3. Available in JSTOR.
- Morley, J., C.R. Nelson and E. Zivot (2002), "Why are Beveridge Nelson and Unobserved Components Decompositions of GDP so Different?". Working paper, Department of Economics, University of Washington.
- ***Campbell, J.Y. and P. Perron (1991),** "Pitfalls and Opportunities: What Macroeconomists Should Know About Unit Roots," *NBER Macroeconomics Annual*, Cambridge, MA: MIT Press.
- Phillips, P.C.B. and Z. Xiao (1997), "A Primer on Unit Root Testing," Cowles Foundation Discussion Paper.
- *Stock, J.S. (1995), "Unit Roots and Trend Breaks", in *Handbook of Econometrics*, Vol 4.
- Zivot, E. and D.W.K. Andrews (1992), "Further Evidence on the Great Crash, the Oil Price Shock and the Unit Root Hypothesis," *Journal of Business and Economic Statistics* 10, 251-70. Re-printed in *Journal of Business and Economic Statistics*, 20(1), January 2002.

TOPIC 4: COVARIANCE STATIONARY VECTOR TIME SERIES

- Demiralp S. and K. D. Hoover, (2000), "Structural VARs," U.C. Davis, manuscript.
- Den Haan, W. J. and A. Levin, (1997), " A Practioner's Guide to Robust Covariance Matrix Estimation," *Handbook of Statistics* 15 (Chapter 12, 291-341)
- *Den Haan, W. J. and A. Levin, (1996), " Inferences from Parametric and Non-Parametric Covariance Matrix Estimation Procedures," NBER Technical Working Paper 195. Both papers can be downloaded from: http://weber.ucsd.edu/~wdenhaan/papers.html
- *Engle, R. F., D. F. Hendry, and J.-F. Richard, (1983), "Exogeneity," *Econometrica*, 51, 277-305.
- *Granger, C. W. J. (1980), "Testing for Causality: A Personal Viewpoint," *Journal of Economic Dynamics and Control*, 2, 329-352
- Granger, C. W. J. (1989), *Modelling Economic Series*, Oxford: Oxford University Press.
- ***Hamilton, Chapters 10-11.**
- *Hendry, D. F. (1995), *Dynamic Econometrics*, Oxford: Oxford University Press.
- Hoover, K. D. and S. M. Sheffrin, (1992), " Causation, Spending, and Taxes: Sand in the Sandbox or Tax Collector for the Welfare State?" *American Economic-Review*; 82(1), 225-48.
- Newey W. N. and K. D. West (1987), "A Simple Positive Semi-Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, 55, 703-708.
- *Reinsel, G. C. (1993), *Elements of Multivariate Time Series Analysis*, New York: Springer-Verlag.
- Swanson, N. R. and C. W. J. Granger, (1997), "Impulse Response Functions Based on a Causal Approach to Residual Orthogonalization in Vector Autoregressions," Journal of the American Statistical Association, 92(437), 357-367.
- Sims, C.A. (1980), "Macroeconomics and Reality," *Econometrica*, 48, 1-48. Available in JSTOR.
- Sims, C.A. (1992), "Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy," *European Economic Review*.
- ***Blanchard, O.J. and D. Quah (1989),** "The Dynamic Effects of Aggregate Demand and Supply Disturbances," *American Economic Review*, 79, 655-673. Available in JSTOR.
- Bernanke, B. (1986), "Alternative Explanations of the Money-Income Correlation," *Carnegie Rochester Conference Series on Public Policy*, 25, 49-99.

- **Gali, J. (1992),** "How Well Does the ISLM Model Fit Postwar Data?" *Quarterly Journal of Economics* 107, 709-735.
- King, R.G. and M. Watson (1997), "Testing Long-Run Neutrality," Federal Reserve Bank of Richmond *Economic Quarterly*, Vol. 83/3.
- Sarte, P-D (1997), "On the Indentification of Structural Vector Autoregressions," Federal Reserve Bank of Richmond *Economic Quarterly*, Vol. 83/3.
- **Stock and Watson (2001),** "Vector Autoregressions", Journal of Economic Perspectives, 15(4).
- Watson, M. (1995), "VARs and Cointegration" chapter 47 (section 4) in *Handbook of Econometrics*, Vol 4.

TOPIC 5: GENERALIZED METHOD OF MOMENTS

- ***Hamilton, Chapter 14**.
- *Hayashi, Chapters 3-4.

TOPIC 6: COINTEGRATION

- ***Engle, R. F. and C. W. J. Granger, (1991),** *Long-Run Economic Relationships*, Oxford: Oxford University Press.
- *Johansen, S. (1995), *Likelihood-Based Inference in Cointegrated Vector-Autoregressive Models*, Oxford: Oxford University Press.
- **Hamilton, Chapters 19-20.**
- ***Sims, C. A., J. H. Stock and M. W. Watson, (1990),** "Inference in Time Series Models with some Unit Roots," Econometrica, 58, 113-44.
- Watson, M. W. (1994), "Vector Autoregressions and Cointegration," *in Handboof of Econometrics*, Vol. IV, eds. D. McFadden and R. F. Engle. Amsterdam: North-Holland.
- **Campbell, J.Y. and P. Perron (1991),** "Pitfalls and Opportunities: What Macroeconomists Should Know About Unit Roots," *NBER Macroeconomics Annual*, Cambridge, MA: MIT Press.
- Stock, J.S. and M.Watson (1988), "Variable Trends in Economic Time Series," *Journal of Economic Perspectives*, Vol 2, No. 3. Available in JSTOR.

TOPIC 7: TIME SERIES MODELS FOR HIGHER MOMENTS AND TRANSITION DATA

- Bergin, Paul R. and Òscar Jordà (2001) "Measuring Monetary Policy Interdependence," U.C. Davis, *mimeo*.
- **Engle, Robert F. (1995)** ARCH. Selected Readings, Oxford: Oxford University Press.
- **Engle, Robert F. and Jeffrey R. Russell (1998)** "Autoregressive Conditional Duration: A New Model for Irregularly Spaced Transaction Data," *Econometrica*, V. 66, N. 5, 1127-1162.
- *Hamilton, James D. and Òscar Jordà (2002) "A Model for the Federal Funds Target," *Journal of Political Economy*, vol. 110, n. 5, 1135-1167.
- ***Hamilton, Chapter 21.**
- Jordà, Oscar Holly Liu and Jeffrey Williams (2002) "Non-institutional Market Making Behavior: The Dalian Futures Exchange," U.C. Davis, *mimeo*.
- *Marcellino, Massimiliano and Òscar Jordà (2002) "Modelling High-Frequency FX Data Dynamics," *Macroeconomic Dynamics*, forthcoming.

TOPIC 8: STATE SPACE MODELING AND THE KALMAN FILTER

- ***Hamilton, Chapter 13.**
- *Hamilton, J. D. (1994), "State-Space Models," in Handbook of Econometrics, Vol. IV, R. F. Engle and D. L. McFadden, eds. Amsterdam: North-Holland.

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

TOPIC 9: BOOTSTRAP METHODS IN ECONOMETRICS

- **Berkowitz, J. and L. Kilian (2000),** "Recent Developments in Bootstrapping Time Series," *Econometric Reviews*, 19(1), 1-48.

Nota:
La nota final se aproxima de la siguiente manera: desde .25 y .75 para arriba se aproxima al siguiente *número superior y de .24 y .74 para abajo se aproxima al siguiente número inferior. Ejemplo; 3.25 pasa a 3.5* y 3.24 pasa a 3.0.

Fecha de Retiro:
El estudiante podrá retirar el curso, sin devolución, hasta un día hábil antes de la fecha de entrega del examen final.