Universidad Carlos III de Madrid

FACULTAD DE CIENCIAS SOCIALES **DEPARTAMENTO DE ECONOMIA**

Econometrics III (1st four weeks)

MSc. in Economic Analysis
2020/2021

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The objective of this part of the course is to deal with some important topics in the empirical analysis of micro data (households, firms, etc.). We will study issues in the specification, estimation and testing of different models with cross-sectional and with panel data. The econometric techniques covered here will be useful in the economic applications from wide range of fields: Labour Economics, Health Economics, Economics of Education, Industrial Organization, Evaluation of Public Policies, etc. This part of the course will be complemented by Applied Economics course that you can take this term.

Prerequisites: Econometrics I and Econometrics II. Students are expected to know well and review before the course GMM, MLE, and other Extremum Estimators. This includes asymptotic properties of these estimators, testing, and selecting optimal instruments (in a GMM setting).

Program

1. Linear Models for Panel Data

Introduction and motivation. Review of Static models and control for unobserved heterogeneity: Within-groups, between-groups and Random Effects Methods.

Dynamic models. Models with strictly exogenous and predetermined variables. The bias of the FD and the within-groups estimator. GMM estimation of dynamic panel data models. Specification tests.

Examples of applications of these methods:
- I.O.: Identification and Estimation of Production Functions (e.g. Productivity in the telecommunications equipment industry). Olley and Pakes (1996); Ackerberg, Caves and Fraser (2006); and its comparison with Arellano and Bover (1995) and Blundell and Bond (1998, 2000).

- Labour and Education Economics: Estimates of the Return to Schooling. Ashenfelter and Krueger (1994)
- Labor and Health Economics: "Can Pay Regulation Kill? Panel Data Evidence on the Effect of Labor Markets on Hospital Performance" Propper and van Reenen (2010)

2. Discrete Choice Models

Introduction and motivation. Review of binary choice models for cross sectional data: linear probability models, probit and logit models. Maximum likelihood, semi-parametric, and non-parametric estimation. Interpretation.

Multiple choice models: multinomial probit and multinomial logit. Simulated method of moments estimation. Ordered probit.

Binary choice models for panel data. Fixed-T solutions: static and dynamic models, random effects and fixed effects approaches to account for unobserved heterogeneity, identification problems and set identified parameters of interest. General solutions to fixed effects estimation (T is not fixed): bias correction methods; Group Effects Estimation.

Endogenous explanatory variables in binary choice models.

Limitations of the homogeneous linear index specification.

Examples of applied papers using these methods:
- Health Economics: “State dependence and heterogeneity in health using a bias corrected fixed effects estimator”. J. Carro and A. Traferri (2014).

- Labour Economics: "State dependence, serial correlation and heterogeneity in intertemporal labor force participation of married women", D. Hyslop (1999)

3. Sample Selection Models and selection models with micro-data

Applications. Truncated Regression Models. Tobit: Censored Regression Models. Sample selection models: maximum likelihood estimation and two-stage estimation. Unbalanced panels. Missing observations and missing information.

Example of an applied paper using these methods: “The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions”, Mroz (1987)

General Textbooks

Wooldridge or Cameron and Trivedi cover many of the topics, but no textbook covers all aspects. Arellano covers in depth the first chapter, but does not cover any other chapter. Further indications of chapters of these textbooks for each topic will be given in class.

Arellano, M. (2002), *Panel Data Econometrics*. Oxford University Press.

Cameron, C. and P. Trivedi, (2005) *Microeconometrics*, Cambridge University Press.
Companion book: Cameron, C. and P. Trivedi (2009), *Microeconometrics Using Stata*, Stata Press.

Wooldridge, J.M. (2002), *Econometric Analysis of Cross Section and Panel Data*. The MIT Press.

An additional Textbook, not specific to microeconometrics, with a GMM-centered approach that you can use to review the Econometrics you should know as prerequisite for this course is:
Hayashi, F. *Econometrics*. Princeton University Press, 2000.

References and Further Readings by topic

1.- Linear Models for Panel Data

Books and chapters in books

- Chamberlain, G. (1984), "Panel Data", in Griliches, Z. and M.D. Intrilligator (eds) *Handbook of Econometrics*, II, Elsevier Science, Amsterdam.
- Arellano, M. And B. Honoré (2001), "Panel Data Models: Some Recent Developments", in Heckman, J.J. and E. Leamer (eds) *Handbook of Econometrics*, V, Ch. 53, Elsevier Science, Amsterdam.

Papers

The Dynamics of Productivity in the Telecommunications Equipment Industry
Olley, S. and A. Pakes (1996),
Econometrica, vol. 64, no. 6, pp. 1263-1298.

Structural Identification of Production Functions
Ackerberg, D., K. Caves and G. Fraser (2006), mimeo, UCLA

Another Look at the Instrumental Variable Estimation of Error-Components Models Arellano, M. Arellano and O. Bover (1995)
Journal of Econometrics, vol. 68, no. 1, pp. 29-51.

Initial conditions and moment restrictions in dynamic panel data models
Richard Blundell, Stephen Bond
Journal of Econometrics, 87 (1998), 115-143

GMM Estimation with Persistent Panel Data: An Application to Production Functions
Richard Blundell, Stephen Bond
Econometrics Reviews, 19 (2000), 321-340

Estimates of the Economic Return to Schooling from a New Sample of Twins
Orley Ashenfelter; Alan Krueger
The American Economic Review, Vol. 84, No. 5. (Dec., 1994), pp. 1157-1173.

Can Pay Regulation Kill? Panel Data Evidence on the Effect of Labor Markets on Hospital Performance
C. Propper and J. van Reenen (2010)
Journal of Political Economy, Vol. 118, No. 2 (April 2010), pp. 222-273

Pooling Cross Section and Time Series Data in the Estimation of a Dynamic Model: The Demand for Natural Gas
Pietro Balestra; Marc Nerlove
Econometrica, Vol. 34, No. 3. (Jul., 1966), pp. 585-612.

Specification Tests in Econometrics
J. A. Hausman
Econometrica, Vol. 46, No. 6. (Nov., 1978), pp. 1251-1271

Estimation of Dynamic Models with Error Components
T. W. Anderson; Cheng Hsiao
Journal of the American Statistical Association, Vol. 76, No. 375. (Sep., 1981), pp. 598-606.

Multivariate regression models for panel data
Gary Chamberlain
Journal of Econometrics, Vol. 18, No. 1, January 1982, Pages 5-46

Formulation and estimation of dynamic models using panel data
T. W. Anderson, Cheng Hsiao
Journal of Econometrics, Vol. 18, No. 1, January 1982, Pages 47-82

The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households
Robert E. Hall; Frederic S. Mishkin
Econometrica, Vol. 50, No. 2. (Mar., 1982), pp. 461-482.

Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations
Manuel Arellano; Stephen Bond
The Review of Economic Studies, Vol. 58, No. 2. (Apr., 1991), pp. 277-297.

An Empirical Analysis of Cigarette Addiction
Gary S. Becker; Michael Grossman; Kevin M. Murphy
The American Economic Review, Vol. 84, No. 3. (Jun., 1994), pp. 396-418.

Efficient estimation of models for dynamic panel data
Seung C. Ahn and Peter Schmidt
Journal of Econometrics, Vol. 68, No. 1, July 1995, Pages 5-27

The Time Series and Cross-Section Asymptotics of Dynamic Panel Data Estimators
Javier Alvarez and Manuel Arellano
Econometrica, Vol. 71, No. 4. (Jul., 2003), pp. 1121-1159.

Orthogonal Parameters and Panel Data
Tony Lancaster
The Review of Economic Studies, Vol. 69 (2002), pp. 647-666

2.- Discrete Choice Models

Books

- Maddala, G.S. (1983), *Limited-dependent and qualitative variables in econometrics*. Cambridge University Press.
- Amemiya, T. (1985), *Advanced econometrics*. Harvard. University Press
- Train, K.E. (2003), *Discrete Choice Methods with Simulation*, Cambridge University Press.

Chapters in Books

- Chamberlain, G. (1984), "Panel Data", in Griliches, Z. and M.D. Intrilligator (eds) *Handbook of Econometrics*, II, Elsevier Science, Amsterdam.

- Arellano, M. And B. Honoré (2001), “Panel Data Models: Some Recent Developments”, in Heckman, J.J. and E. Leamer (eds) *Handbook of Econometrics*, V, Ch. 53, Elsevier Science, Amsterdam.
- Chamberlain,G.(1985),‘‘Heterogeneity,Omitted Variable Bias,and Duration Dependence,’’in Longitudinal Analysis of Labor Market Data ,ed.J.J.Heckman and B.Singer.Cambridge:Cambridge University Press,3 –38.
- Hajivassiliou, V. and P. Ruud, (1994), "Classical estimation methods for LDV models using simulation", in R. Engle and D. McFadden, eds., *Handbook of Econometrics*, 1994, North-Holland, Amsterdam, pp. 2383–2441.
- McFadden, D. (1974), ‘Conditional logit analysis of qualitative choice behavior’,in P. Zarembka, ed., *Frontiers in Econometrics*, Academic Press, New York, pp. 105– 142.
- McFadden, D. (1978), ‘Modeling the choice of residential location’, in A. Karlqvist, L. Lundqvist, F. Snickars, and J. Weibull, eds., *Spatial Interaction Theory and Planning Models*, North-Holland, Amsterdam, pp. 75–96.
- McFadden,D.L.(1984),‘‘Econometric Analysis of Qualitative Response Models,’’in *Handbook of Econometrics*, Volume 2,ed.Z.Griliches and M.D.Intriligator.Amsterdam:North Holland,1395 –1457.
- Arellano, M and J. Hahn (2007): “Understanding Bias in Nonlinear Panel Models: Some Recent Developments.” in R. Blundell, W. Newey, and T. Persson (eds.): *Advances in Economics and Econometrics, Ninth World Congress*, Cambridge University Press.
- Browning, M. and J. Carro (2007): “Heterogeneity and Microeconometrics modelling.” in R. Blundell, W. Newey, and T. Persson (eds.): *Advances in Economics and Econometrics, Ninth World Congress*, Cambridge University Press.

Papers

A conditional probit model for qualitative choice: Discrete decisions recognizing interdependence and heterogeneous preferences
Hausman, J. and D. Wise
Econometrica 48 (1978), 403–429.

Analysis of Covariance with Qualitative Data
Chamberlain, G.
Review of Economic Studies, 47(1) (1980) , pages 225-38.

Specification tests for the multinomial logit model
Hausman, J. and D. McFadden
Econometrica 52 (1984), 1219–1240.

A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data
Heckman,J.J.,and B.Singer
Econometrica 52 (1984),271 –320.

Semiparametric Analysis of Random Effects Linear Models from Binary Panel Data
Manski,C.F.
Econometrica 55 (1987),357 –362.

Discrete Choices with Panel Data
Manuel Arellano
Investigaciones Economicas 27 (2003), 423-458.

Panel Data Discrete Choice Models with Lagged Dependent Variables
Honore, B.E., and E.Kyriazidou
Econometrica 68 (2000),839 –874.

Binary choice panel data models with predetermined variables
Manuel Arellano and Raquel Carrasco
Journal of Econometrics 115 (1) (2003), pages 125-157.

Jackknife and Analytical Bias Reduction for Nonlinear Panel Models
Jinyong Hahn and Whitney K. Newey.
Econometrica 72 (2004), 1295-1319.

Estimating dynamic panel data discrete choice models with fixed effects
Jesús M. Carro
Journal of Econometrics 140 (2007), pages 503-528.

Nonlinear Panel Data Analysis
M. Arellano and S. Bonhomme
Annual Review of Economics, 3. Pp. 395-424 (2011)

State dependence, serial correlation and heterogeneity in intertemporal labor force participation of married women
D. R. Hyslop (1999)
Econometrica, 67: 1255-1294

Estimating The Effects Of A Time-Limited Earnings Subsidy For Welfare-Leavers
D. Card and D. Hyslop (2005)
Econometrica, 67(6): 1295-1339.

State dependence and heterogeneity in health using a bias corrected fixed effects estimator.
J. Carro and A. Traferri (2014).
Journal of Applied. Econometrics, 29: 181-207. DOI: 10.1002/jae.2301

Average and Quantile Effects in Nonseparable Panel Models
V. Chernozhukov, I. Fernández-Val, J. Hahn, and W. Newey (2013).
Econometrica 81 (2), 535 –580.

Grouped Patterns of Heterogeneity in Panel Data
S. Bonhomme and E. Manresa (2015)
Econometrica 83 (3), 1147 –1184.

Discretizing Unobserved Heterogeneity
S. Bonhomme, T. Lamadon E. Manresa (2017), *mimeo*.

Identification of Average Marginal Effects in Fixed Effects Dynamic Discrete Choice Models
V. Aguirregabiria and J. M. Carro (2020), *mimeo*

3.- Sample Selection Models

Papers

Estimation of Relationships for Limited Dependent Variables
James Tobin
Econometrica, Vol. 26, No. 1. (Jan., 1958), pp. 24-36.

Social Experimentation, Truncated Distributions, and Efficient Estimation
Jerry A. Hausman; David A. Wise
Econometrica, Vol. 45, No. 4. (May, 1977), pp. 919-938.

Sample Selection Bias as a Specification Error
James J. Heckman
Econometrica, Vol. 47, No. 1. (Jan., 1979), pp. 153-162.

Symmetrically Trimmed Least Squares Estimation for Tobit Models
James L. Powell
Econometrica, Vol. 54, No. 6. (Nov., 1986), pp. 1435-1460.

The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions
Thomas A. Mroz
Econometrica, Vol. 55, No. 4. (Jul., 1987), pp. 765-799.

Estimating Models with Sample Selection Bias: A Survey
Francis Vella
The Journal of Human Resources, Vol. 33, No. 1. (Winter, 1998), pp. 127-169.

Discrete Choice Non-Response
Ramalho, E. A., and R. J. Smith
The Review of Economic Studies, Vol. 80 No. 1 (2013), pp. 343-364.

Correlated random effects models with unbalanced panels
J. Wooldridge (2019).
Journal of Econometrics, 211 (1): 137-150.

Estimation of Dynamic Nonlinear Random Effects Models with Unbalanced Panels
P. Albarran, R. Carrasco and J. Carro (2019).
Oxford Bulletin of Economics and Statistics. doi: 10.1111/obes.12308

ECONOMETRICS III (II part: TIME SERIES ECONOMETRICS)
Master-Ph.D. FAll 2020

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Description

Advanced Econometrics I (Introduction to Time Series Analysis) examines the models and statistical techniques used to study time series data in economics. A central message is that THEORETICAL time series analysis is useful because it helps us understand patterns in actual economic data, as well as dynamic CAUSAL relationships.

The course has two specific objectives. The first is to equip students with the tools necessary for state-of-the-art empirical research with economic time series data. This is designed for those students who are likely to use time series data in their Ph.D. theses (macro-economics, finance, marketing, accounting,...etc). The second objective is to lay out the econometric theory of time series analysis, with an emphasis on recent developments during the past 10-20 years.

The first block of the course presents the theory of univariate stationary and non-stationary time series variables. The second block focus on the multivariate level covering the different aspects of the VAR modelling that have been relevant in the recent macroeconomic time series literature. The last block consists of some further topics that have become recently very popular in time series econometrics (some of these topics are excellent candidates to write a dissertation on).

Grading

The course work consists of a final exam (take home + exam in class), five problem sets that will require theoretical and computationally work and a FIVE-pages project. The project can be theoretical or applied (see the web page of the course). For the applied project this year we will focus on the causal relationship between interest rates and seasonally adjusted GNP (or IPI). The question to analyze is how effective is the monetary policy. Grades for this course will be based on the final exam (70%), and the project (30%). The problem sets are a necessary condition in order to get a final grade. I encourage individuals to work together on the problem sets. You will undoubtedly teach each other more about time series while working in a problem set than I will in class. Each individual is, however, required to turn in a separate problem set answer sheet.

Software

Econometrics and Time Series software: E-views, Matlab, STATA, R, etc. I recommend the students to become familiar as soon as possible with at least two of the packages (E-views or STATA and R or Matlab). One menu-driven (good to analyze empirical data) and the other one better designed for programming (good for simulations).

COURSE OUTLINE

BLOCK 0: INTRODUCTION

1. BASIC CONCEPTS OF STOCHASTIC PROCESSES
   Definitions and examples of stochastic processes and time series. Stationarity and ergodicity. The mean. The autocovariance and autocorrelation function. One of the goals of time series analysis: Forecasts based on conditional expectation and Forecasts based on linear projection (least squares).

BLOCK I: MODELS BASED ON UNIVARIATE INFORMATION

2. STATIONARY LINEAR MODELS I: CHARACTERIZATION AND PROPERTIES
   Wold's decomposition. Causal and Invertible ARMA processes. The Partial autocorrelation function. The Autocovariance generating function. Identification of ARMA processes.

3. STATIONARY LINEAR MODELS I': SPECTRAL ANALYSIS
   Spectral Densities. The Periodogram. Time-Invariant Linear Filters. The Spectral density of an ARMA process.

4. STATIONARY LINEAR MODELS II: ESTIMATION AND INFERENCE
   Estimation: The maximum likelihood method (the likelihood function for a gaussian AR(1) and a gaussian MA(1)) and Least squares. Asymptotic behavior of the sample mean and autocovariance function. Estimation of the Long-Run Variance. Inference on the parameters of ARMA models.
   Appendix: Asymptotics for linear processes (LLN and CLT). Martingale Theory.

5. MODEL SELECTION
   Box-Jenkins Methodology. Information Criteria: AIC, BIC, HQ and LCIC. Consistency of the IC. Inference on models selected by the IC (big problem !!New Solution?). Testing versus IC. Model Averaging (Big Data).

6. FORECASTING
   Forecasts from ARMA and ARIMA models. The prediction function and its economic interpretation. Combination of forecasts (Ecological Principle). Evaluation of forecasts. Example of Model selection via forecasting: comparisons of trend-stationary and unit root processes.

7. NON-STATIONARY LINEAR MODELS: THE CASE OF AN AR WITH A UNIT ROOT
   Deterministic trends versus stochastic trends. Processes with unit roots: Testing and Estimation. Decompositions in trend and cycle: Beveridge-Nelson decomposition and orthogonal decompositions. NEW work on Trends.
   Appendix: The functional central limit theorem and the continuous mapping theorem.

8. NON-STATIONARY MODELS: THE CASE OF STRUCTURAL BREAKS
   Testing for a Single Break. Testing for Multiple Breaks. Unit Roots versus Breaks.

BLOCK II: MODELS BASED ON MULTIVARIATE INFORMATION

9. STATIONARY MULTIVARIATE LINEAR MODELS: VARs
   Structural VAR models. Identication of Shocks: Short-run conditions; Long-run conditions (example: Blanchard and Quah); Via Sign restrictions; Via Heterokedasticity, etc. Stability, Estimation and inference in VAR models. Lag selection. Transfer functions derived from VAR models. Bivariate Granger causality tests. Impulse-response function. Variance decomposition. Standard errors for impulse-response functions. VARX. New: VAR on Networks.

10. NON-STATIONARY MULTIVARIATE LINEAR MODELS I: VAR MODELS WITH UNIT ROOTS- COINTEGRATION
    Spurious regression. Cointegration. Implications of cointegration for the VAR representation: the Error correction model (Granger's representation theorem). Testing for cointegration and estimation of the cointegrating vector: A single equation approach (OLS and DOLS). Testing for the rank of cointegration and estimation of the cointegrating vectors: A simultaneous equation approach (Reduced Rank Regression). Consequences of misspecification of the trend components on testing for cointegration.
    Appendix: Asymptotic results for non-stationary vector processes.

11. NON-STATIONARY MULTIVARIATE LINEAR MODELS II: VAR MODELS WITH UNIT ROOTS- COINTEGRATION
    Common trends representations. Permanent and Transitory Decompositions: Stock-Watson and Gonzalo-Granger representations. Identification of the shocks of a cointegrated VAR: Gonzalo-Ng approach.

12. MODEL SELECTION
    Consequences of lag or/and rank misspecification in VARs. Information criteria approach to select the number of lags and the rank of cointegration. Consistency of the IC; Testing versus IC.

BLOCK III: FURTHER TOPICS

13. LONG MEMORY
    Definition. How long-memory appears in Economics. Modelling. Estimation and inference. Testing I(1) versus I(d). Testing I(d) versus I(0)+ Breaks.

14. NON-LINEARITIES: THRESHOLD MODELS
    Threshold autoregressive models. Conditions for Stationarity. Estimation, Inference and Model Identification. Testing linearity. The Case of Threshold Unit Root (TARUR and TARSUR Models).

15. DYNAMIC FACTOR MODELS
    Standard Factor Models. Determination of the number of Factors. Inferential Theory for Factor Models. FAVAR. New: Quantile Factor Models.

16. FUTURE OF TIME SERIES ECONOMETRICS
    Big Data. Machine Learning. Networks. Applications to Climate Econometrics, etc.

TEXTBOOKS

The primary texts are **Brockwell and Davis** (1991), **Hamilton** (1994), and **Hayashi** (2000). The other texts provide treatments of various subtopics.

Primary Texts

Hamilton, J., *Time Series Analysis*. Princeton University Press, 1994.

Hayashi, F., *Econometrics*. Princeton University Press, 2000.

Brockwell, P.J. and R.A. Davis, *Time Series: Theory and Methods*. New York. Springer-Verlag, second edition, second printing 2009.

Secondary Texts (for particular topics)

Anderson, T., *The Statistical of Time Series*. Wiley, 1971.

Baltagi, B. editor of *A Companion to Theoretical Econometrics*. Blackwell, 2001.

Banerjee, A., J. Dolado, J.W. Galbraith, and D.F. Hendry, *Co-Integration, Error-Correction and the Econometric Analysis of Non-Stationary Data*. Oxford University Press, 1993.

Beran, J., *Statistics for Long-Memory Processes*. Chapman-Hall. 1994.

Box, G.E.P, G.M. Jenkins, *Time Series Analysis: Forecasting and Control*. San Francisco: Holden-Day, 1976.

Breiman, L., *Probability* (Classics in Applied Mathematics No. 7). SIAM. 1992.

Brockwell, P.J. and R.A. Davis, *Introduction to Time Series and Forecasting*. New York. Springer-Verlag, 1996.

Burnham, K. and D. Anderson, *Model Selection and Inference. A Practical Information-Theoretic Approach*. Springer 1998.

Campbell, J., Lo, A. and A. MacKinlay, *The Econometrics of Financial Markets*. Princeton. 1997.

Canova, F.,*Methods for Applied Macroeconomic Research*. Princeton, 2007.

Choi, B., *ARMA Model Identification*. Springer. 1992.

Claeskens, G. and N. Hjort, *Model Selection and Model Averaging*. Cambridge, 2012.

Clements, M.P. and D.F. Hendry, *Forecasting Economic Time Series*. Cambridge. 1998.

Cramer, H., and M.R. Leadbetter, *Stationary and Related Stochastic Processes*. Wiley, 1967.

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

Dejong, D., and Ch. Dave, *Structural Macroeconometrics*. Princeton, 2007.

Dhrymes, P., *Time Series, Unit Roots, and Cointegration*. Academic Press, 1998.

Elliott, G., A. Timmermann, *Economic Forecasting*. Princeton University, 2016.

Enders, W., *Applied Econometric Time Series*. John Wiley. 1995.

Fan, J., and Q. Yao, *Nonlinear Time Series*. Springer. 2003.

Fuller, W., *Introduction to Statistical Time Series*. John Wiley. 1995.

Giraud, C. *Introduction to High-Dimensional Statistics*. Chapman and Hall. 2015.

Gourieroux, C. and A. Monfort, *Time Series and Dynamic Models*. Cambridge, 1997.

Granger, C.W.J. and Newbold, P., *Forecasting Economic Time Series*, second edition. New York: Academic Press, 1986.

Granger, C.W.J, Timo Tersvirta, and Dag Tjostheim, *Modelling Nonlinear Economic Time Series*. Oxford University Press, 2010.

Hansen, B., *Econometrics*. Manuscript at
http://www.ssc.wisc.edu/ bhansen/notes/notes.htm

Johansen, S., *Likelihood-Based Inference on Cointegrated VAR Models*. Oxford University Press, 1995.

Juselius, K., *The Cointegrated VAR Model*. Oxford University Press, 2006.

Killian, L. and H. Lutkepohl, *Structural Vector Autoregressive Analysis*. Cambridge. 2017.

Li, Wai K.,*Diagnostic Checks in Time Series*. Chapman and Hall 2004.

Lutkepohl, H., *Inroduction to Multiple Time Series Analysis*, second edition. Springer Verlag, 1993.

Hall, P. and C.C. Heyde, *Martingale Limit Theory and Its Applications.* Academic Press. 1980.

G.S. Maddala and In-M. Kim, *Unit Roots, Cointegration, and Structural Change.* Cambridge. 1998.

Mikosch, T., *Elementary Stochastic Calculus.* World Scientific Publishing. 1998.

Mills, T., *The Econometric Modelling of Financial Time Series.* Cambridge University Press. 1997 (second edition).

Mills, T., and K. Patterson (editors), *Palgrave Handbook of Econometrics, vol 1. Econometric Theory.* Palgrave Macmillan. 2006.

Mittelhammer, R., *Mathematical Statistics for Economics and Business.* Springer Verlag, 1995.

Pesaran, H., *Time Series and Panel Data Econometrics.* Oxford. 2015.

Potscher, B.M. and I.R. Prucha, *Dynamic Nonlinear Econometric Models, Asymptotic Theory.* Springer Verlag. 1997.

Priestley, M.B., *Spectral Analysis and Time Series*, vols. 1 and 2 together. London: Academic Press, 1987.

Reinsel, G., *Elements of Multivariate Time Series Analysis.* Springer. 1993.

Robinson, P. (editor), *Time Series with Long Memory.* Oxford University Press, 2003.

Saxe, K. *Beginning Functional Analysis.* Springer. 2001.

Shiryayev, A.N. *Probability.* Springer. 1984.

Shumway, R.H. and D. Stoffer, *Time Series and Its Applications.* Springer. 2000.

Taniguchi, M., and Y. Kakizawa, M., *Asymptotic Theory of Statistical Inference for Time Series.* Springer, 2000.

Tong, H., *Non-Linear Time Series: A Dynamical System Approach.* Oxford. 1990.

Wei,W., *Time Series Analysis: Univariate and Multivariate Methods.* Addinson Wesley, 1990.

White, H., it Asymptotic Theory for Econometricians: Revised Edition. Academic Press, 2001.

+ Lecture Notes and Papers provided in the web page

I hope you enjoy the course. GOOD LUCK

WHAT TO DO WHEN THIS COURSE IS FINISHED?
Note that part of the material of this course will be complemented by other Advanced Econometrics courses offered in this PhD program. Particularly I encouraged all of you to take courses like the Topic Courses on Introduction to Empirical Processes (by W. Stute and or Juan Carlos Escanciano), Introduction to Bootstrap (by E. Paparoditis), Stochastic Calculus (by D.Nualart) or similar. These courses are NOT only designed for those students thinking on writing a dissertation on Econometrics. The courses will be useful for anyone aiming to write a good dissertation in Economics.