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Fall 2020

# ECONOMICS 613
## Economic and Financial Time Series (I)

## COURSE OBJECTIVES

This course is concerned with recent developments in the time series techniques for the analysis of economic and financial markets. It provides a rigorous, nevertheless user-friendly, account of the time series techniques dealing with univariate and multivariate time series models. The topics to be covered include an overview of basic econometric techniques, an introduction to stochastic processes, univariate and multivariate time series, tests for unit roots, cointegration, impulse response analysis, autoregressive conditional heteroscedasticity models, simultaneous equation models, vector autoregressions, causality, forecasting, multivariate volatility models, and models subject to structural change. The techniques will be illustrated using *Microfit 5.5* with applications to real output, inflation, interest rates, exchange rates and stock prices.

*Prerequisite:* ECON 609

**LECTURE TIMES:** Mondays, 9:00 a.m. -11:50 a.m.
First Class - Aug 17, 2020 No Class - Sep 7, 2020 (Labor Day)
Last Class – Nov 09, 2020

**LOCATION:** **Online**

**OFFICE HOURS:** Mondays 2:00-3:00 p.m. or by appointment only. Contact Akiko Matsukiyo, amatsu@usc.edu for scheduling.

**TA**: Zhan Gao (zhangao@usc.edu)

**COURSE WEBPAGE :** https://blackboard.usc.edu

**TAKE HOME PROBLEM SETS :** The problem sets will be assigned and posted on blackboard on August 24, Sep 7, Sep 21, Oct 5, Oct 19, Oct 26 and due on Sep 7, Sep 21, Oct 5, Oct 19, Nov 2, Nov 16 respectively.

| | Post Date | Due Date |
|---|---|---|
| Problem Set 1 | Aug 24 | Sep 7 |
| Problem Set 2 | Sep 7 | Sep 21 |
| Problem Set 3 | Sep 21 | Oct 5 |
| Problem Set 4 | Oct 5 | Oct 19 |

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| Problem Set 5 | Oct 19 | Nov 2 |
| Problem Set 6 | Nov 2 | Nov 16 |

**MIDTERM EXAM:** September 28, 2020

**FINAL EXAM:** **To be confirmed** (between Nov. 17 – 24)

**GRADING:** The final grade will be based on problem sets (40%), a midterm exam (30%) and a final exam (30%).

**COURSE TEXTBOOK:** I shall be using the following text:

**Pesaran, M.H.,** (2015), *Time Series and Panel Data Econometrics*. Oxford University Press, Oxford (ISBN 978-0-19-875998-0), required

In addition, I shall post handouts on Blackboard as required. The following texts are also recommended as optional:

**Tsay, R. S.,** (2010), *Analysis of Financial Time Series*, 3rd Edition, Wiley, New York. (ISBN-13: 978-0-470-41435-4, ISBN: 0-470-41435-9), recommended

**Campbell, J.Y., A.W. Lo, A.C. MacKinlay,** (1997), *The Econometrics of Financial Markets*, Princeton University Press, New Jersey. (ISBN: 0-691-04301-9), optional

**Hamilton, J.D.**, (1994), *Time Series Analysis*, Princeton University Press, New Jersey. (ISBN: 0-691-04289-6), optional

**Enders, Walter,** (2003), *Applied Econometric Time Series, 2nd Edition*, Wiley, New York (ISBN-0-471-23065-0), optional

**Garratt, A., Lee, K., Pesaran, M.H., Shin, Y.,** (2006), *Global and National Macroeconometric Modelling: A Long-Run Structural Approach*, Oxford University Press. Oxford (ISBN 0-19-929685-5), optional

**Wayne Ferson,** (2019), *Emprical Asset Pricing: Models and Methods*, The MIT Press. Massachusetts (ISBN: 978-0262039376), optional

**COMPUTER PROGRAM:**

The course will make use of **Microfit 5.5**, a freeware downloadable from
http://www.econ.cam.ac.uk/people-files/emeritus/mhp1/Microfit/Microfit.html
But students are free to use whatever software package they find most convenient.

**Pesaran, B., and M.H. Pesaran,** (2009), *Time Series Econometrics: Using Microfit 5.0*, Oxford University Press, Oxford. (ISBN10: 0-19-956353-5) required.

**COURSE OUTLINE:**

**Basic Econometrics** - Regression Analysis (an overview)

Classical linear regression model and its assumptions:
Estimation, OLS, maximum likelihood, generalized method of moments, multicollinearity, goodness of fit measures, hypothesis testing, dummy variables, seasonal corrections, and structural stability tests
**Pesaran (2015), Chapters 1, 2, 3**

Departures from the classical model:
Residual serial correlation, heteroscedasticity, dependence between regressors and the equation's disturbance term, functional form misspecification, and non-normal errors
**Pesaran (2015), Chapters 4, 5**
Diagnostic tests:
DW, h and LM tests of residual serial correlation, Ramsey's test of functional form misspecification, Jarque-Bera test of normality, and simple tests of heteroscedasticity
**Pesaran (2015), Sections 4.5 and 5.8**
Hamilton (1994), Chapter 8, Greene Chapters 3-6,

Model selection criteria:
Akaike's Information Criterion, Schwarz's Bayesian information criterion and other model selection criteria
**Pesaran (2015), Sections 11.4 and 11.5**
Hamilton (1994), Chapter 8, PP (2009), Chapters 6 &11

**Univariate Time Series Models – Modelling the Conditional Mean**

Stationary stochastic processes:
Basic concepts (information sets, conditional expectations, conditional variance, stationarity, ergodicity, etc.) Autocorrelation function and spectral density function.
**Pesaran (2015), Chapters 12, 13**
Hamilton (1994), Chapter 6

Univariate linear time series techniques:
Wold decomposition theorem and the moving average representation of stationary processes. Autoregressive (AR) and Autoregressive and Moving-average (ARMA) models. Estimation and hypothesis testing. Decomposition of stationary processes into trend, seasonal and cyclical components. States pace models.
**Pesaran (2015)**, **Chapter 14**
Tsay (2010) Chapters 2 & 11, PP(2009) Chapter12, Hamilton (1994) Chapters3 & 13.

Non-stationary time series:
Models with deterministic trends (trend stationary models), models with unit roots (first difference stationary models), random walk models. Trend stationary versus first-difference stationary processes. Random Walk models versus models with mean reversion. Properties of models with unit roots (integrated processes). Persistence of shocks in models with unit roots and their measurement. Testing for unit roots. Asymptotic theory and Monte Carlo results.
**Pesaran (2015), Chapters 15, 16**
Tsay (2010) Chapters 2& 11, PP(2009) Chapter 12, Hamilton (1994) Chapter 17.

Forecasting and Structural Change:
Point, interval and probability forecasts,Forecast evaluation: MSFE, market timing tests, decision-based forecast evaluation techniques,Parameter instability and forecasting, Random coefficient models, Recursive estimation and recursive modelling ("Real Time Econometrics"), CUSUM and CUSUM of Squares tests, and Recursive F tests, Choice of observation window (expanding, rolling and exponential decay windows)
**Pesaran (2015), Chapter 17**
Tsay (2010) Chapter 2, PP(2009) Chapters 6&12, Hamilton (1994) Chapter 4.

**Univariate Time Series – Modelling the Conditional Variance**

RiskMetrics volatility estimators, Equally weighted, exponentially weighted, Models with variable conditional variances, Autoregressive conditional heteroscedastic (ARCH) models, Generalized ARCH models (GARCH), Mean-variance relations, GARCH-in-mean models
**Pesaran (2015), Chapter 18**
Tsay (2010), Chapter 3, PP (2009) Chapters 8 &19

**Multivariate Time Series – VAR models, Cointegration, and Vector Error Correction Models**

VARs, univariate representations and Granger non-causality, Cointegration and error correction models, Granger representation theorem, Alternative methods of testing for cointegration, Identification and estimation of cointegrating vectors subject to restrictions (Long-run structural modelling), Testing restrictions on the cointegrating relations. Impulse response analysis and error variance decomposition (orthogonalized and generalized approaches).

**Pesaran (2015), Chapters 21, 22**
Tsay (2010) Chapter8, PP (2009) Chapters7,15 & 22, Hamilton (1994) Chapter 19

**Applications**

Modelling Stock Returns – Present Value Models, VAR models in asset prices, dividends and interest rates. Campbel, Lo and MacKinlay (1997), Chapter 7.
A vector error correcting model of the UK, Garratt, Lee, Pesaran and Shin (2006), Chapter 9
Application of cointegration analysis to the term structure of interest. PP (2009), Lesson 16.7
Modelling volatility in asset prices (daily, weekly and monthly returns)
**Pesaran (2015), Section 25.8**
Tsay (2010) Chs, 1 and 3, PP (2009), Lessons in Chapter 19.

**Further Readings (books)**
The time series econometric literature is vast and growing. In what follows, I have chosen a number of key references which have been particularly important in shaping the recent developments in the subject.

Among the numerous texts published on time series, the classic text of Box and Jenkins is still a must. The third edition, written with Gregory Reinsel, is recommended:

**Box, G.E.P., G.M. Jenkins, and G.C. Reinsel,** (1994), *Time Series Analysis: Forecasting and Control*, third edition, Prentice Hall, New Jersey. (ISBN: 0-130-60774-6)

The latest edition of Chatfield's text also provides a good introduction to the subject:

**Chatfield, C.**, (1996), *The Analysis of Time Series: An Introduction,* fifth edition, Chapman and Hall Ltd, London.

The text by Fuller is also worthwhile consulting as it contains a rigorous treatment of the distribution theory of sample estimates of ARIMA processes and gives an account of the unit root problem:

**Fuller, W. A.**, (1996), *Introduction to Statistical Time Series*, second edition, John Wiley, New York. (ISBN: 0-471-55239-9)

The text by Brockwell and Davis also provides a rigorous treatment of the univariate time series model:

**Brockwell, P.J. and R.A. Davis,** (1991), *Time Series: Theory and Methods,* Second Edition. Springer, New York. (ISBN: 3-540-97429-6)

As far as the analysis of multivariate time series is concerned, I recommend

**Lutkepohl, H.**, (1991), *Introduction to Multiple Time Series Analysis*, Springer Verlag, New York. (ISBN: 3-540-53194-7)

This is an excellent text, but despite its introductory nature it is still quite advanced.

In addition to the above texts, there are also a number of books that have been written especially for economists. In this category the following texts are recommended:

**Johansen, S.**, (1995), *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, Oxford University Press, Oxford. (ISBN: 0-19-877450-8)

**Choi, I.** (2015), Almost All *Almost All about Unit Roots: Foundations, Developments, and Applications),* Cambridge University Press, Cambridge. (ISBN: *978-1-107-48250-0*)

**Pesaran, M.H. and M. Wickens,** (1995), *Handbook of Applied Econometrics: Macroeconomics,* Basil Blackwell, Oxford. (ISBN: 0-631-21558-1)

Johansen's book provides a rigorous analysis of cointegration. The recent book by Choi is more comprehensive and up-to-date and less technical.

The focus of the above texts (as well as the course) is on linear time series models. For non-linear forecasting methods the following texts are recommended:

**Granger, C.W.J., and T. Terasvirta,** (1993), *Modelling Nonlinear Economic Relations,* Oxford University Press, Oxford. (ISBN: 0-19-877319-6)

**Tong, H.**, (1993), *Non-Linear Time Series: Dynamical System Approach*, Oxford University Press, Oxford. (ISBN: 0-19-852300-9)

**General Texts in Econometrics**

In addition to the above texts on time series, the following general econometrics texts are also useful for the course:

**Davidson, R. and J.G., MacKinnon**, (1993), *Estimation and Inference in Econometrics*, Oxford University Press, Oxford (ISBN: 0-19-506011-3)

**Geweke, John, Joel L. Horowitz and Hashem Pesaran.** "Econometrics." The New Palgrave Dictionary of Economics. Second Edition. Eds. Steven N. Durlauf and Lawrence E. Blume. Palgrave Macmillan, 2008. The New Palgrave Dictionary of Economics Online. Palgrave Macmillan. http://www.dictionaryofeconomics.com/article?id=pde2008_E000007

**Greene, W. H.**, (2008), *Econometric Analysis*, (6th Edition) Prentice-Hall (ISBN: 0-130-110849-2)

**Wooldridge, J.M.** (2013), *Introductory Econometrics: A Modern Approach*, (5th Edition), South-Western (ISBN: 978-1-111-53104-1).

**Bruce Hansen** (2020), *Econometrics*. Manuscript to be published.
Chapter 1 – 13 provides a nice overview of basic econometrics covered in the first year Ph.D. class

**Stachurski, J.** (2016). *A Primer in Econometric Theory*. MIT Press. (ISBN: 0262034905)
A gentle introduction to econometrics as well as statistical computing for students with no formal training in econometrics.