

Objective: In ECON412 we examine some aspects of time-series and nonstationary panel data econometrics that are widely used in the estimation and testing of macroeconomic relationships. Upon successful completion of ECON412, you should be able to:

- Demonstrate an understanding of contemporary econometric methods used in time-series and panel time-series data analysis in macroeconomic contexts
- Interpret and critically evaluate applied time-series and panel time-series econometric studies in the literature.
- Apply macroeconometric methods, using appropriate computer software, to relevant data in practice and interpret the results obtained.
- Explain the relevant estimation and testing methods and interpretation of results.

Prerequisites: The paper assumes knowledge of econometrics roughly equivalent to the material covered in ECON375 Econometrics, including familiarity with the basics of at least one of the main econometric or statistical software packages (e.g., Stata, EViews, OxMetrics, R).

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Lecture times: Tuesday 12-12.50am & Wednesday 2-3.50pm, Semester 1
Location: to be advised through EVision

Realistically, this semester is going to be disrupted by the spread of the Omicron variant of COVID-19. At any stage, any of us could have to isolate because we are unwell, have tested positive for COVID or are close contacts. Consequently, to make the best of a sub-optimal situation, we will have to be flexible in our response.

The intention is to start with in-person lectures at the times listed above. In line with the University's guidelines, this will require social distancing (> 1.5 metres) and masks to be worn (unless an exemption has been granted). Lecture recordings (either of the live sessions or pre-recorded) will be available if anyone is not able to attend due to illness or isolating. However, if in-person lectures turn out to be infeasible, lectures will shift completely online. All changes to arrangements will be posted on Blackboard.

Workload: Note that ECON412 is a 20-point semester paper. Under the University's points conventions, this corresponds approximately to an average workload of 16 hours per week (including contact hours), or roughly 240 hours in total over a 15-week period (including the end-of-semester exam period).

Lecture notes: Copies of lecture overheads and assignments will be posted in advance on Blackboard (<https://blackboard.otago.ac.nz/>). To minimize contact, hard copies of handouts will not be distributed in class. For recordings, go to the 'Tools' page (left-hand menu) and then 'Echo 360 Recordings'. Clicking on this link will redirect you to the ECON412 recordings

Office hours: Instead of fixed office hours, if you have any queries on any aspect of the paper, please email me in the first instance and we can follow this up, as needed, with a Zoom call.

Assessment: Conventionally, ECON412 has a final exam, but given the uncertainty associated with COVID-19, including the possibility of having to take lectures and assessment online, ECON412 in 2022 will be 100% internally assessed, based on four assignments (each worth 25% of the overall mark), which can be submitted by email (in Word or pdf format).

Due dates:	Assignment 1 23 March	Assignment 2 27 April
	Assignment 3 18 May	Assignment 4 18 June*

*subject to confirmation

Academic Integrity

Academic integrity means being honest in your studying and assessments. It is the basis for ethical decision-making and behaviour in an academic context. Academic integrity is informed by the values of honesty, trust, responsibility, fairness, respect and courage. Students are expected to be aware of, and act in accordance with, the University's Academic Integrity Policy.

Academic Misconduct, such as plagiarism or cheating, is a breach of Academic Integrity and is taken very seriously by the University. Types of misconduct include plagiarism, copying, unauthorised collaboration, taking unauthorised material into a test or exam, impersonation, and assisting someone else's misconduct. A more extensive list of the types of academic misconduct and associated processes and penalties is available in the University's Student Academic Misconduct Procedures.

It is your responsibility to be aware of and use acceptable academic practices when completing your assessments. To access the information in the Academic Integrity Policy and learn more, please visit the University's Academic Integrity website at www.otago.ac.nz/study/academicintegrity or ask at the Student Learning Centre or Library.

Topics and Reading

The list below is relatively extensive. Don't be put off by this! You are **not** expected to read everything. The aim is to provide a range of material that you can choose from depending on which areas you need to reinforce or in which you have a particular interest (e.g., because you are using specific techniques in your dissertation). Some of the more advanced material may be of use beyond this course.

A taste of what 'cointegration' is about can be obtained from the material posted on the Nobel Prize website commemorating the award of the Nobel Prize in Economics in 2003 to Professor Clive Granger. This includes a video of Professor Granger's prize lecture at:

http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2003/granger-lecture.html

General reading: (* denotes reading that is initially the most accessible).

Useful texts:

K. Patterson, *An Introduction to Applied Econometrics: A Time Series Approach*, Macmillan, 2000.

W. Enders, *Applied Econometric Time Series*, 4th Edition, John Wiley, 2015.*

D.F. Hendry and B. Nielsen, *Econometric Modeling: A Likelihood Approach*, Princeton University Press, 2007.*

J.L. Castle and D.F. Hendry, *Modelling Our Changing World*, Palgrave Macmillan, 2019.* downloadable at

<https://link.springer.com/book/10.1007%2F978-3-030-21432-6>

W.W. Charemza, and D.F. Deadman, *New Directions in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autoregression*, Second Edition, Edward Elgar, 1997.*

K. Juselius, *The Cointegrated VAR Model: Methodology and Applications*, Oxford University Press, 2006.

M. Soderbom, F. Teal, M. Eberhardt, S. Quinn and A. Zeitlin, *Empirical Development Economics*, Routledge, 2015.*

B.H. Baltagi, *Econometric Analysis of Panel Data* (5th ed.), JohnWiley, 2013.

More technically advanced treatments are available in:

A. Banerjee, 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.

D. Hendry, *Dynamic Econometrics*, Oxford University Press, 1995.

D.F. Hendry and J.A. Doornik, *Empirical Model Discovery and Theory Evaluation: Automatic Selection Methods in Econometrics*, MIT Press, 2014.

D.F. Hendry, *Introductory Macro-econometrics: A New Approach*, Timberlake Consultants Ltd, 2015, downloadable at

<http://www.timberlake.co.uk/media/wysiwyg/intromacroeconometrics/DFHMacroEcts15.pdf>

J. L. Castle and D. F. Hendry, *Climate Econometrics: An Overview*, Foundations and Trends in Econometrics, vol. 10, no. 3-4, pp.145-322, 2020, downloadable at <http://dx.doi.org/10.1561/08000000037>

R. Nymoen, *Dynamic Econometrics for Empirical Macroeconomic Modelling*, World Scientific, 2020.

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

A. Spanos, *Probability Theory and Statistical Inference: Empirical Modeling with Observational Data*, Cambridge University Press, 2019.

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

K. Patterson, *A Primer for Unit Root Testing*, Palgrave Macmillan, 2010.

K. Patterson, *Unit Root Tests in Time Series, Volume 1: Key Concepts and Problems*, Palgrave Macmillan, 2011.

V. Martin, S. Hurn and D. Harris, *Econometric Modelling with Time Series: Specification, Estimation and Testing*, Cambridge University Press, 2013 (Part 5).

Concise single textbook chapters that introduce some of the key concepts, at an accessible level, include:

J.M. Wooldridge, *Introductory Econometrics: A Modern Approach*, 7th Edition, Cengage, 2020, Chapter 18.*

Other useful textbook coverage of some of the material in this paper is given in:

K.G. Stewart, *Introduction to Applied Econometrics*, Brooks/Cole Thomson Learning, 2005, Chs 15-18.*

M. Verbeek, *A Guide to Modern Econometrics*, 4th Edition, Wiley, 2012, Chs 8-9.

An accessible set of YouTube videos by Ben Lambert covers some of the material in the course. These are mostly included in the undergraduate course in econometrics playlists (parts 1 and 2) at <https://www.youtube.com/user/SpartacanUsuals/playlists>; the most relevant are listed in the individual topics below.

Topics and specific reading:

References in **bold** are highly recommended (most are available on eReserve via the ECON412 Blackboard page). References in squared brackets are more advanced readings. Topics and readings are a general guide; changes may be made depending on our rate of progress, relevant new references, etc.

1. Motivation and a review of basic concepts in time series analysis: stochastic processes, DGPs, realizations and models; stationarity and non-stationarity, order of integration

Nobel Prize in Economics 2003, resources cited above

Patterson, *op. cit.*, Chs 1-3.

D.F. Hendry, *Econometrics - alchemy or science?*, *Economica*, 47, 1980, 387-406, reprinted in D.F. Hendry, *Econometrics - Alchemy or Science?*, Blackwell, 1993, pp.11-28.

Banerjee et al, *op. cit.*, Introduction and Overview, Ch. 1, especially pp.1-13, 27-42.

Castle and Hendry, 2019, *op. cit.*, Chs 2 and 3.

A. Spanos, *Econometrics in retrospect and prospect*, in T.C. Mills and K. Patterson, (eds), *Palgrave Handbook of Econometrics, Volume 1: Econometric Theory*, Palgrave MacMillan, 2006, pp. 3-58.

[Hendry, 1995, *op. cit.*, Ch. 2.]

B. Lambert YouTube videos, undergrad part 1 playlist, #166-168, 170-172

2. Autocorrelation and partial autocorrelation functions; autoregressive (AR), moving average (MA), ARMA, and ARIMA processes; stationarity and invertibility; outline of Box-Jenkins modelling

For a brief introduction:

K. Cuthbertson, S.G. Hall, and M.P. Taylor, *Applied Econometric Techniques*, Philip Allan, 1992, Ch. 3.

Patterson, *op. cit.*, Sections 6.1, 6.2, 7.2.

Verbeek, *op. cit.*, Sections 8.1-8.3, 8.6-8.9.

More detailed coverage is available in, for example:

T.C. Mills, *Time Series Techniques for Economists*, CUP, 1990 (especially Chs. 5, 6, & 8).

B. Lambert YouTube videos, undergrad part 1 playlist, #173-182; part 2 playlist, #3-4

3. Autoregressive distributed lag models, special cases (including differenced data, common factor models), error correction mechanisms and general-to-specific modelling

For general discussions of the LSE/Hendry methodology, including diagnostic testing and encompassing:

Charemza and Deadman, *op. cit.*, Ch.4 (and Ch. 3).

C.L. Gilbert, Professor Hendry's econometric methodology, *Oxford Bulletin of Economics and Statistics*, 48, 1986, 283-307.

Hendry and Nielsen, *op. cit.*, especially Chs 11 and 13.

Hendry, *op. cit.*, 2015, especially Ch. 4.

D.F. Hendry, The methodology of empirical econometric modeling: Applied econometrics through the looking glass, in T.C. Mills and K. Patterson (eds), *Palgrave Handbook of Econometrics, Volume 2: Applied Econometrics*, Palgrave Macmillan, 2009, pp. 3-67.

A. Spanos, Reflections on the LSE Tradition in Econometrics: A student's perspective, *OEconomia*, 4, 2014, 343-380.

A. Spanos, Mis-specification testing in retrospect, *Journal of Economic Surveys*, 32(2), 2018, 541-577.

Patterson, *op. cit.*, Ch. 1.

B. Lambert YouTube video on general-to-specific modelling

https://www.youtube.com/watch?v=p4c_ZBFNpL0

For a detailed discussion of the AD(1,1) model and models nested in it:

Hendry, 1995, *op. cit.*, Ch. 7.

B. Lambert YouTube videos, undergrad part 2 playlist, #1-2, 5-7; part 1 playlist, 199

For insights into more recent developments in general-to-specific modelling:

Hendry and Nielsen, *op. cit.*, Ch. 19.

Hendry and Doornik, *op. cit.*

Castle and Hendry, 2019, *op. cit.*, Ch.6.

Nymoen, *op.cit.*, Ch. 11

4. Non-stationarity in economic time series - random walks, difference stationary vs trend stationary models, problems with integrated series using 'standard' econometric techniques, spurious regressions

Banerjee et al, *op. cit.*, Ch. 3.

Patterson, *op. cit.*, Sections 6.2.4 - 6.2.8.

Stewart, *op. cit.*, Sections 17.1-17.2

B. Lambert YouTube videos, undergrad part 1 playlist, #168-169, 183-187, 192

5. Testing for unit roots - Dickey-Fuller, augmented Dickey-Fuller, Phillips-Perron tests, more powerful tests, practical examples

Patterson, *op. cit.*, Sections 6.3, 6.4, 7.3, 7.6, 7.9, 7.10 [7.4, 7.5, 7.7, 7.8].

Banerjee et al, *op. cit.*, Ch. 4, especially pp. 99-119.

Enders, *op. cit.*, Ch.4.

J. Elder and P.E. Kennedy, Testing for unit roots: What should students be taught? *Journal of Economic Education*, 32(2), 2001, 137-146.

Stewart, *op. cit.*, Sections 17.3-17.4

P. Perron, Trends and random walks in macroeconomic time series: Further Evidence from a new approach, *Journal of Economic Dynamics and Control*, 12, 1988, 297-332.

B. Lambert YouTube videos, undergrad part 1 playlist, #188-191

6. Cointegration, long-run relationships, tests for non-cointegration, Engle-Granger 2-step method, Granger representation theorem, testing for cointegration via the ECM

Patterson, *op. cit.*, Ch. 8 with case studies in Chs 10-13.

Banerjee et al, *op. cit.*, Ch. 7, especially pp. 204-238.

M.P. Murray, A drunk and her dog: An illustration of cointegration and error correction, *The American Statistician*, 48(1), 1994, 37-39.

N.R. Ericsson and J.G. MacKinnon, Distributions of error correction tests for cointegration, *Econometrics Journal*, 5, 2002, 285-318.

Castle and Hendry, 2019, *op. cit.*, Ch.4.

Castle and Hendry, 2020, *op. cit.*, Ch.7 (application to UK annual CO₂ emissions).

Stewart, *op. cit.*, Ch. 18

Charemza and Deadman, *op.cit.*, Ch. 5.

[R.F. Engle and C.W.J. Granger, Co-Integration and error correction: representation, estimation and testing, *Econometrica*, 55, 1987, 251-276.]

B. Lambert YouTube videos, undergrad part 1 playlist, #193-196; part 2 playlist, 6-7

7. Cointegration in multivariate systems, the Johansen approach, modelling with integrated variables

Patterson, *op. cit.*, Ch. 14 with applications in Ch. 15.

Hendry and Nielsen, *op. cit.*, Ch. 17

K. Juselius, Searching for a theory that fits the data: a personal research odyssey, *Econometrics*, 9, 2021, 27pp. <https://www.mdpi.com/2225-1146/9/1/5> (open access)

[Martin et al., *op. cit.*, Ch. 18.]

[Juselius, *op. cit.*, especially parts II-IV.]

[Verbeek, *op. cit.*, Sections 9.4-9.8.]

8. Panel unit roots and cointegration: key characteristics of panel time-series: nonstationarity, parameter heterogeneity, cross-sectional dependence; testing for panel unit roots, cross-sectional dependence, cointegration; estimation in heterogeneous parameter models: mean group, augmented mean group, and common correlated effects estimators

M. Söderbom, F. Teal, M. Eberhardt, S. Quinn and A. Zeitlin, *Empirical Development Economics*, Routledge, 2014, Chs 26-28.*

M.H. Pesaran, On the interpretation of panel unit root tests. *Economics Letters*, 116(3), 2012, 545-546.

J. Ditzen, Estimating dynamic common-correlated effects in Stata. *The Stata Journal*, 18(3), 2018, 585-617.

Baltagi, *op. cit.*, Ch. 12.

Pesaran, *op. cit.*, Chs 28, 29 and 31.

[A. Banerjee and M. Wagner, Panel methods to test for unit roots and cointegration, in T.C. Mills and K. Patterson (eds), *Palgrave Handbook of Econometrics, Volume 2: Applied Econometrics*, Palgrave Macmillan, 2009, pp. 632-726.]

[J. Westerlund, Testing for error correction in panel data, *Oxford Bulletin of Economics and Statistics*, 69, 2007, 709-748.]

[A. Chudik and M.H Pesaran, Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors, *Journal of Econometrics*, 188, 2015, 393-420.]