Princeton University **Spring 2019**
Department of Economics **ECO 513**

Advanced Econometrics: Time Series Models

Syllabus: Version 5 (April 25, 2019)

Instructors:	Mikkel Plagborg-Moller, mikkelpm@princeton.edu Ulrich Müller, umueller@princeton.edu
Lectures:	Tue/Thu 10.40am–12.10pm, JRR 298
Office hours:	Tue 1.30–2.30, JRR 282 (Plagborg-Moller) Please sign up on http://wase.princeton.edu

Description. Concepts and methods of time series analysis and their applications to economics. Time series models to be studied include simultaneous stochastic equations, VAR, ARIMA, and state-space models. Methods to analyze trends, second-moment properties via the autocovariance function and the spectral density function, methods of estimation and hypothesis testing and of model selection will be presented. Kalman filter and applications as well as unit roots, cointegration, ARCH, and structural breaks models are also studied.

Prerequisites. ECO 517 and 518, or equivalent. Students from outside the Economics PhD program should contact the instructors to obtain permission to take the course.

Material. The course material is self-contained and there is no required textbook for the course. Handouts covering most of the material will be made available on the website. Some students might find it useful to have a textbook as an additional reference. Good reference books are:

Brockwell, P. J., and Davis, R. A. (1991). *Time Series: Theory and Methods.* 2nd edition, Springer. (A beautiful mathematical treatment of the classic theory of covariance stationary time series, but not aimed at economists.)

Davidson, J. (1994). *Stochastic Limit Theory.* Oxford University Press. (Thorough, technical treatment of stochastic limit theory for dependent data.)

Hall, P., and Heyde, C. C. (1980). *Martingale Limit Theory and Its Application.* Academic Press. (Well-written technical treatment of martingale asymptotics.)

Hamilton, J. D. (1994). *Time Series Analysis*. Princeton University Press. (Comprehensive reference for time series econometrics methods developed before the mid-1990s.)

Hayashi, F. (2000). *Econometrics*. Princeton University Press. (Accessible treatment of GMM and stochastic limit theory for time series data.)

Herbst, E. P., and Schorfheide, F., (2015). *Bayesian Estimation of DSGE Models*. Princeton University Press. (Recent reference on computational methods for Bayesian inference in nonlinear structural time series models.)

Kilian, L., and Lütkepohl, H. (2017). *Structural Vector Autoregressive Analysis*. Cambridge University Press. (Recent reference on VAR and SVAR methods for applied macro.)

Lütkepohl, H. (2005). *New Introduction to Multiple Time Series Analysis*. Springer. (Comprehensive treatment of estimation and inference in VARIMA models.)

This syllabus also includes a list of additional readings that are useful for a deeper understanding of the material. Many of these readings are available electronically.

Homework. Problem sets will be posted on the course website every one or two weeks. The due date will typically be one week after the assignment is posted. Problem sets should be printed out and handed in at the beginning of class on the due dates. Students are encouraged to collaborate on the problem sets, but answers and computer code must be typed up independently. Problem sets will be graded coarsely, i.e., a full score will be given as long as the work demonstrates dedication and thoughtfulness. The instructors reserve the right to subtract points for sloppy exposition, including unreadable code or poor document structure. If you find a grading error, please resubmit your problem set along with a one-paragraph explanation; the instructors reserve the right to re-grade the entire problem set.

Exams. The course will feature a final exam in the form of a 24-hour take-home exam. No collaboration is allowed on the final. Questions will be a mix of pen-and-paper exercises and coding.

Grading. The final course grade will be a monotonic function of the weighted average of (i) the average problem set score (40% weight) and (ii) the final exam score (60% weight).

Code of conduct. All course activities, including class meetings and homework assignments, are subject to the university's academic code and code of conduct as detailed in the "Rights, Rules, Responsibilities" publication.

Accommodations for students with disabilities. Students must register with the Office of Disability Services (ODS) (ods@princeton.edu; 258-8840) for disability verification and determination of eligibility for reasonable academic accommodations. Requests for academic accommodations for this course need to be made at the beginning of the semester, or as soon as possible for newly approved students, and again at least two weeks in advance of any needed accommodations in order to make arrangements to implement the accommodations. Please make an appointment to meet with the instructor in order to maintain confidentiality in addressing your needs. No accommodations will be given without authorization from ODS, or without advance notice.

Important dates. These dates are preliminary. Changes will be announced via course email.

Feb 5 (Tue): First class with M. Plagborg-Moller

Mar 19 (Tue), Mar 21 (Thu): No class due to spring break

Mar 26 (Tue): U. Müller takes over teaching

Apr 23 (Tue): M. Plagborg-Moller resumes teaching

May 2 (Thu): Last class

May 13–14 (Mon): Final exam

Outline for Plagborg-Moller's part of the course. The following outline, which covers only the first six and last two weeks of the course, is preliminary and may change without warning.

1. Stationary models.
    i) Covariance/strict stationarity.
    ii) Autocovariance function.
    iii) VARMA, stationarity, invertibility.

iv) Prediction, Granger/Sims causality, likelihood factorization.

v) VAR estimation, inference, stationary asymptotics.

vi) Bayesian VARs, Bernstein-von Mises theorem.

vii) Wold decomposition.

viii) Model selection.

2. Spectral analysis.

i) Seasonality.

ii) Approximation of arbitrary spectrum by AR/MA.

iii) Periodogram smoothing.

3. Inference with weakly dependent data.

i) Central Limit Theorem, martingale difference sequences, mixing.

ii) Applications to GMM, moment matching.

iii) Bootstrap.

4. State space models.

i) Filtering, smoothing.

ii) Linear case: Kalman filter, likelihood.

iii) Estimation of DSGE models.

iv) Regime switching (time permitting).

v) Particle filter, Sequential Monte Carlo (time permitting).

5. Semi-structural identification and inference.

i) SVMA models.

ii) Impulse responses, variance decompositions, historical decompositions.

iii) Invertibility, SVAR models.

iv) Local projection.

v) Instruments/proxies, recoverability.

vi) Set identification.

6. Long-run variance estimation.

    i) Kernel estimators.

    ii) VAR-HAC.

    iii) Fixed-b asymptotics.

7. Dynamic Factor Models.

    i) State space approach.

    ii) Principal components estimation.

    iii) Inference on number of factors.

8. Non-stationary models.

    i) I(1) processes, Beveridge-Nelson decomposition, VARIMA.

    ii) Spurious regression.

    iii) Bayesian vs. frequentist perspective.

    iv) Frequentist asymptotics for unit roots, local-to-unity.

    v) Detrending (time permitting).

    vi) Cointegration, VECM models (time permitting).

    vii) Müller-Watson long-run inference (time permitting).

Reading list for Plagborg-Moller's part of the course

Introductory readings are listed first and marked with a star (*). Other readings are included for your reference. Original contributions are not always cited when good handbook/textbook references are available. The reading list is preliminary and may change without warning.

1 Stationary models

Models, inference, prediction

* Hayashi: chapters 6.1–6.4.

* Herbst and Schorfheide: chapters 3.1–3.2.

* Lütkepohl: chapters 2–3.

  Brockwell and Davis: chapters 1.1–1.5, 2.1–2.9, 3.1–3.5, 5.1–5.5, 5.7, 11.1–11.4.

  Hamilton: chapters 2–4, 10–12.

  Kilian and Lütkepohl: chapters 2, 5.

  van der Vaart, A. W. (1998). *Asymptotic Statistics*. Cambridge University Press. Chapter 10.

Model selection

* Claeskens, G., and Hjort, N. L. (2008). *Model Selection and Model Averaging*. Cambridge University Press. Chapters 1–4.

* Lütkepohl: chapter 4.

  Brockwell and Davis: chapter 9.

  Geweke, J., and Meese, R. (1981). "Estimating regression models of finite but unknown order." *International Economic Review* 22(1), 55–70.

  Hansen, B. E. (2005). "Challenges for Econometric Model Selection." *Econometric Theory* 21(1), 60–68.

Leeb, H., and Pötscher, B. M. (2005). "Model Selection and Inference: Facts and Fiction." *Econometric Theory* 21(01), 21–59. Sections 1–2.

Applications

Bernanke, B. S., and Kuttner, K. N. (2005). "What Explains the Stock Market's Reaction to Federal Reserve Policy?" *Journal of Finance* 60(3), 1221–1257.

Giannone, D., Lenza, M., and Primiceri, G. E. (2015). "Prior Selection for Vector Autoregressions." *Review of Economics and Statistics* 97(2), 436–451.

Sims, C. A. (1972). "Money, Income, and Causality." *American Economic Review* 62(4), 540–552.

Stock, J. H., and Watson, M. W. (2003). "Forecasting Output and Inflation: The Role of Asset Prices." *Journal of Economic Literature* 41(3), 788–829.

2 Spectral analysis

Representation theory and inference

* Hamilton: chapter 6.

Brockwell and Davis: chapters 4, 10.1–10.5, 11.6.

Berk, N. (1974). "Consistent Autoregressive Spectral Estimates." *Annals of Statistics* 2(3), 489–502.

Hannan, E. J. (1970). *Multiple Time Series*. John Wiley & Sons. Chapters III.2–3, III.5.

Applications

Dew-Becker, I., and Giglio, S. (2016). "Asset Pricing in the Frequency Domain: Theory and Empirics." *Review of Financial Studies* 29(8), 2029–2068.

King, R. G., and Watson, M. W. (1996). "Money, Prices, Interest Rates and the Business Cycle." *Review of Economics and Statistics* 78(1), 35–53.

Qu, Z., and Tkachenko, D. (2012). "Frequency Domain Analysis of Medium Scale DSGE Models with Application to Smets and Wouters (2007)." In *Advances in Econometrics, Volume 28: DSGE Models in Macroeconomics – Estimation, Evaluation and New Developments*, edited by Balke, N., Canova, F., Milani, F., and Wynne, M. A., Emerald Group Publishing, 319–385.

Sala, L. (2015). "DSGE Models in the Frequency Domain." *Journal of Applied Econometrics* 30(2), 219–240.

Sargent, T. J., and Surico, P. (2011). "Two Illustrations of the Quantity Theory of Money: Breakdowns and Revivals." *American Economic Review* 101(1), 109–128.

Watson, M. W. (1993). "Measures of Fit for Calibrated Models." *Journal of Political Economy* 101(6), 1011–1041.

3 Inference with weakly dependent data

Abstract theory

* Hayashi: chapters 2, 6.5.

Brockwell and Davis: chapters 6–7.

Davidson: chapters 13–14, 24.

Hall and Heyde: chapter 3.

Hamilton: chapter 7.

GMM, moment matching

* Hayashi: chapters 7.1–7.4.

Hansen, L. P., Heaton, J., and Yaron, A. (1996). "Finite-Sample Properties of Some Alternative GMM Estimators." *Journal of Business & Economic Statistics* 14(3), 262–280.

Hansen, L. P., and Heckman, J. J. (1996). "The empirical foundations of calibration." *Journal of Economic Perspectives* 10(1), 87–104.

Kydland, F., and Prescott, E. (1996). "The computational experiment: an econometric tool." *Journal of Economic Perspectives* 10(1), 69–85.

Nakamura, E., and Steinsson, J. (2018). "Identification in Macroeconomics." *Journal of Economic Perspectives* 32(3), 59–86.

Newey, W. K., and McFadden, D. L. (1994). "Large sample estimation and hypothesis testing." In *Handbook of Econometrics, Volume IV*, edited by Engle, R. F., and McFadden, D. L., Elsevier, chapter 36, 2111–2245.

Bootstrap

* Kilian and Lütkepohl: chapters 12.1–12.5.

Brüggemann, R., Jentsch, C., and Trenkler, C. (2016). "Inference in VARs with conditional heteroskedasticity of unknown form." *Journal of Econometrics* 191(1), 69–85.

Gonçalves, S., and Kilian, L. (2004). "Bootstrapping autoregressions with conditional heteroskedasticity of unknown form." *Journal of Econometrics* 123(1), 89–120.

Horowitz, J. L. (2001). "The Bootstrap." In *Handbook of Econometrics, Volume 5*, edited by Heckman, J. J., and Leamer, E., Elsevier, chapter 52, 3159–3228.

Kilian, L. (1998). "Small-sample Confidence Intervals for Impulse Response Functions." *Review of Economics and Statistics* 80(2), 218–230.

Applications

Hansen, L. P., and Singleton, K. J. (1982). "Generalized Instrumental Variable Estimation of Nonlinear Rational Expectation Models." *Econometrica* 50(5), 1269–1286.

Mankiw, N. G., Reis, R., and Wolfers, J. (2004). "Disagreement about Inflation Expectations." In *NBER Macroeconomics Annual 2003, Volume 18*, edited by Gertler, M., and Rogoff, K., National Bureau of Economic Research, 209–248.

Mavroeidis, S., Plagborg-Møller, M., and Stock, J. H. (2014). "Empirical Evidence on Inflation Expectations in the New Keynesian Phillips Curve." *Journal of Economic Literature* 52(1), 124–188.

4 State space models

Linear state space models, DSGE estimation

* Hamilton: chapter 13.

* Herbst and Schorfheide: chapters 1–3.

* Griffoli, T. M. (2013). "Dynare User Guide." Sections 3, 5.

Blanchard, O. J., and Kahn, C. M. (1980). "The Solution of Linear Difference Models under Rational Expectations." *Econometrica* 48(5), 1305–1311.

Durbin, J., and Koopman, S. J. (2012). *Time Series Analysis by State Space Methods*. 2nd edition, Oxford University Press.

Sims, C. A. (2002). "Solving Linear Rational Expectations Models." *Computational Economics* 20(1–2), 1–20.

Winberry, T. (2018). "A method for solving and estimating heterogeneous agent macro models." *Quantitative Economics* 9(3), 1123–1151.

Nonlinear filtering

Hamilton: chapter 22.4.

Kitagawa, G. (1987). "Non-Gaussian State-Space Modeling of Nonstationary Time Series." *Journal of the American Statistical Association* 82(400), 1032–1041.

Markov Chain Monte Carlo

* Chib, S. (2001). "Markov Chain Monte Carlo Methods: Computation and Inference." In *Handbook of Econometrics, Volume 5*, edited by Heckman, J. J., and Leamer, E., Elsevier, chapter 5, 3564–3634.

Herbst and Schorfheide: chapters 5, 8–9.

Creal, D. (2012). "A Survey of Sequential Monte Carlo Methods for Economics and Finance." *Econometric Reviews* 31(3), 245–296.

Flury, T., and Shephard, N. (2011). "Bayesian Inference Based Only on Simulated Likelihood: Particle Filter Analysis of Dynamic Economic Models." *Econometric Theory* 27(05), 933–956.

Neal, R. M. (2011). "MCMC Using Hamiltonian Dynamics." In *Handbook of Markov Chain Monte Carlo*, edited by Brooks, S., Gelman, A., Jones, G. L., and Meng, X.-L., chapter 5, 113–162. CRC Press.

Applications

Sims, C. A., and Zha, T. (2006). "Were There Regime Switches in U.S. Monetary Policy?" *American Economic Review* 96(1), 54–81.

Smets, F., and Wouters, R. (2007). "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." *American Economic Review* 97(3), 586–606.

Stock, J. H., and Watson, M. W. (2007). "Why Has U.S. Inflation Become Harder to Forecast?" *Journal of Money, Credit and Banking* 39(S1), 3–33.

5 Semi-structural identification and inference

Identification

* Stock, J. H., and Watson, M. W. (2018). "Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments." *Economic Journal* 128(610), 917–948.

Kilian and Lütkepohl: chapters 4, 7–15, 17.

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

Chahrour, R., and Jurado, K. (2018). "Recoverability." Manuscript, Duke University.

Forni, M., Gambetti, L., and Sala, L. (2018). "Structural VARs and Non-invertible Macroeconomic Models." *Journal of Applied Econometrics*, forthcoming.

Gouriéroux, C., Monfort, A., and Renne, J.-P. (2017). "Statistical inference for independent component analysis: Application to structural VAR models." *Journal of Econometrics* 196(1), 111–126.

Lippi, M., and Reichlin, L. (1994). "VAR analysis, nonfundamental representations, Blaschke matrices." *Journal of Econometrics* 63(1), 307–325.

Mertens, K., and Ravn, M. O. (2013). "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States." *American Economic Review* 103(4), 1212–1247.

Plagborg-Møller, M., and Wolf, C. K. (2018). "Instrumental Variable Identification of Dynamic Variance Decompositions." Manuscript, Princeton University.

Rigobon, R. (2003). "Identification Through Heteroskedasticity." *Review of Economics and Statistics* 85(4), 777–792.

Sims, C. A. (1980). "Macroeconomics and Reality." *Econometrica* 48(1), 1–48.

Uhlig, H. (2005). "What are the effects of monetary policy on output? Results from an agnostic identification procedure." *Journal of Monetary Economics* 52(2), 381–419.

Inference

Barnichon, R., and Brownlees, C. (2018). "Impulse Response Estimation By Smooth Local Projections." *Review of Economics and Statistics*, forthcoming.

Baumeister, C., and Hamilton, J. D. (2015). "Sign Restrictions, Structural Vector Autoregressions, and Useful Prior Information." *Econometrica* 83(5), 1963–1999.

Gafarov, B., Meier, M., and Montiel Olea, J. L. (2018). "Delta-Method Inference for a Class of Set-Identified SVARs." *Journal of Econometrics* 203(2), 316–327.

Giacomini, R., and Kitagawa, T. (2018). "Robust Bayesian inference for set-identified models." Manuscript, University College London.

Jentsch, C., and Lunsford, K. G. (2016). "Proxy SVARs: Asymptotic Theory, Bootstrap Inference, and the Effects of Income Tax Changes in the United States." Federal Reserve Bank of Cleveland Working Paper no. 16-19.

Jordà, O. (2005). "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95(1), 161–182.

Montiel Olea, J. L., Stock, J. H., and Watson, M. W. (2018). "Inference in SVARs Identified with External Instruments." Manuscript, Columbia University.

Plagborg-Møller, M. (2019). "Bayesian Inference on Structural Impulse Response Functions." *Quantitative Economics* 10(1), 145–184.

Plagborg-Møller, M., and Wolf, C. K. (2019). "Local Projections and VARs Estimate the Same Impulse Responses." Manuscript, Princeton University.

Rubio-Ramírez, J. F., Waggoner, D. F., and Zha, T. (2010). "Structural vector autoregressions: Theory of identification and algorithms for inference." *Review of Economic Studies* 77(2), 665–696.

Applications

* Ramey, V. A. (2016). "Macroeconomic Shocks and Their Propagation." In *Handbook of Macroeconomics, Volume 2A*, edited by Taylor, J. B., and Uhlig, H., Elsevier, chapter 2, 71–162.

Gertler, M., and Karadi, P. (2015). "Monetary Policy Surprises, Credit Costs, and Economic Activity." *American Economic Journal: Macroeconomics* 7(1), 44–76.

Wolf, C. K. (2018). "SVAR (Mis)Identification and the Real Effects of Monetary Policy." Manuscript, Princeton University.

6 Long-run variance estimation

Theory

* Hayashi: chapter 6.6.

* Müller, U. K. (2014). "HAC Corrections for Strongly Autocorrelated Time Series." *Journal of Business & Economic Statistics* 32(3), 311–322. Sections 1–3.

Andrews, D. W. K. (1991). "Heteroskedasticity and autocorrelation consistent covariance matrix estimation." *Econometrica* 59(3), 817–858.

Andrews, D. W. K., and Monahan, J. C. (1992). "An Improved Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimator." *Econometrica* 60(4), 953–966.

Den Haan, W. J., and Levin, A. (1997). "A practitioner's guide to robust covariance matrix estimation." In *Handbook of Statistics, Volume 15*, edited by Maddala, G. S., and Rao, C. R., North-Holland, 299–342.

Dou, L. (2019). "Optimal HAR Inference." Manuscript, Princeton University.

Ibragimov, R., and Müller, U. K. (2010). "t-Statistic Based Correlation and Heterogeneity Robust Inference." *Journal of Business and Economic Statistics* 28(4), 453–468.

Jansson, M. (2004). "The Error in Rejection Probability of Simple Autocorrelation Robust Tests." *Econometrica* 72(3), 937–946.

Kiefer, N. M., and Vogelsang, T. J. (2005). "A New Asymptotic Theory for Heteroskedasticity–Autocorrelation Robust Tests." *Econometric Theory* 21(6), 1130–1164.

Lazarus, E., Lewis, D. J., and Stock, J. H. (2017). "The Size–Power Tradeoff in HAR Inference." Manuscript, Harvard University.

Lazarus, E., Lewis, D. J., Stock, J. H., and Watson, M. W. (2018). "HAR Inference: Recommendations for Practice." *Journal of Business and Economic Statistics* 36(4), 541–559. See also comments and rejoinder in the same journal issue.

Müller, U. K. (2007). "A theory of robust long-run variance estimation." *Journal of Econometrics* 141(2), 1331–1352.

Newey, W. K., and West, K. D. (1987). "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica* 55(3), 703–708. *Review of Economic Studies* 61(4), 631–653.

Pötscher, B. M. (2002), "Lower Risk Bounds and Properties of Confidence Sets for Ill-Posed Estimation Problems with Applications to Spectral Density and Persistence Estimation, Unit Roots, and Estimation of Long Memory Parameters." *Econometrica* 70(3), 1035–1065.

Sun, Y. (2014). "Let's Fix It: Fixed-b Asymptotics versus Small-b Asymptotics in Heteroscedasticity and Autocorrelation Robust Inference." *Journal of Econometrics* 178(3), 659–677.

Sun, Y., Phillips, P. C. B., and Jin, S. (2008). "Optimal Bandwidth Selection in Heteroskedasticity–Autocorrelation Robust Testing." *Econometrica* 76(1), 175–194.

Applications

Dew-Becker, I. (2017). "How Risky Is Consumption in the Long-Run? Benchmark Estimates from a Robust Estimator." *Review of Financial Studies* 30(2), 631–666.

7 Dynamic Factor Models

Estimation and inference

* Stock, J. H., and Watson, M. W. (2016). "Dynamic Factor Models, Factor-Augmented Vector Autoregressions, and Structural Vector Autoregressions in Macroeconomics." In *Handbook of Macroeconomics, Volume 2A*, edited by Taylor, J. B., and Uhlig, H., Elsevier, chapter 8, 415–525. Sections 1–3, 5–6.

Kilian and Lütkepohl: chapter 16.

Bai, J. (2003). "Inferential Theory for Factor Models of Large Dimensions." *Econometrica* 71(1), 135–171.

Bai, J., and Ng, S. (2008), "Large Dimensional Factor Analysis." *Foundations and Trends in Econometrics* 3(2), 89–163.

Doz, C., Giannone, D., and Reichlin, L. (2012). "A Quasi-Maximum Likelihood Approach for Large, Approximate Dynamic Factor Models." *Review of Economics and Statistics*, 94(4), 1014–1024.

Forni, M., Giannone, D., Lippi, M. and Reichlin, L. (2009). "Opening the Black Box: Structural Factor Models with Large Cross Sections." *Econometric Theory* 25(5), 1319–1347.

Forni, M., Hallin, M., Lippi, M., and Reichlin, L. (2000). "The Generalized Dynamic-Factor Model: Identification and Estimation." *Review of Economics and Statistics* 82(4), 540–554.

Stock, J. H., and Watson, M. W. (2002). "Forecasting Using Principal Components From a Large Number of Predictors." *Journal of the American Statistical Association* 97(460), 1167–1179.

Determining the number of factors

Bai, J., and Ng, S. (2002). "Determining the Number of Factors in Approximate Factor Models." *Econometrica* 70(1), 191–221.

Onatski, A. (2009). "Testing Hypotheses About The Number of Factors in Large Factor Models." *Econometrica* 77(5), 1447–1479.

Applications

Bernanke, B. S., Boivin, J., and Eliasz, P. (2005). "Measuring the effects of monetary policy: a factor-augmented vector autoregressive (FAVAR) approach." *Quarterly Journal of Economics* 120(1), 387–422.

Bok, B., Caratelli, D., Giannone, D., Sbordone, A. M., and Tambalotti, A. (2017). "Macroeconomic Nowcasting and Forecasting with Big Data." *Annual Review of Economics* 10, 615–643.

8 Non-stationary models

Unit roots

* Hayashi: chapter 9.

Hamilton: chapters 15–17.

Beveridge, S., and Nelson, C. R. (1981). "A new approach to decomposition of economic time series into permanent and transitory components with particular attention to measurement of the 'business cycle'." *Journal of Monetary Economics* 7(2), 151–174.

Elliott, G., Rothenberg, T. J., and Stock, J. H. (1996). "Efficient Tests for an Autoregressive Unit Root." *Econometrica* 64(4), 813–836.

Hansen, B. E. (1999). "The Grid Bootstrap and the Autoregressive Model." *Review of Economics and Statistics* 81(4), 594–607.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., and Shin, Y. (1992). "Testing the null hypothesis of stationarity against the alternative of a unit root." *Journal of Econometrics* 54(1–3), 159–178.

Mikusheva, A. (2007). "Uniform inference in autoregressive models." *Econometrica* 75(5), 1411–1452.

Phillips, P. C. B. (1990). "To criticize the critics: An objective Bayesian analysis of stochastic trends." *Journal of Applied Econometrics* 6, 333–364. See also comments and rejoinder in the same journal issue.

Sims, C. A. (2000). "Using a likelihood perspective to sharpen econometric discourse: Three examples." *Journal of Econometrics* 95(2), 443–462. Section 2.

Sims, C. A., and Uhlig, H. (1991). "Understanding Unit Rooters: A Helicopter Tour." *Econometrica* 59(6), 1591–1599.

Stock, J. H. (1991). "Confidence intervals for the largest autoregressive root in U.S. macroeconomic time series." *Journal of Monetary Economics* 28(3), 435–459.

Stock, J. H. (1994). "Unit roots, structural breaks and trends." In *Handbook of Econometrics, Volume 4*, edited by Engle, R. F., and McFadden, D. L., Elsevier, chapter 46, 2739–2841. Sections 1–3, 6.

Detrending

Baxter, M., and King, R. G. (1999). "Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series." *Review of Economics and Statistics* 81(4), 575–593.

Christiano, L. J., and Fitzgerald, T. J. (2003). "The Band Pass Filter." *International Economic Review* 44(2), 435–465.

Cogley, T., Nason, J. M. (1995). "Effects of the Hodrick-Prescott filter on trend and difference stationary time series: Implications for business cycle research." *Journal of Economic Dynamics and Control* 19(1), 253–278.

Hamilton, J. D. (2017). "Why You Should Never Use the Hodrick-Prescott Filter." *Review of Economics and Statistics* 100(5), 831–843.

Hodrick, R. J., and Prescott, E. C. (1997). "Postwar U.S. Business Cycles: An Empirical Investigation." *Journal of Money, Credit and Banking* 29(1), 1–16.

Ravn, M. O., and Uhlig, H. (2002). "On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations." *Review of Economics and Statistics* 84(2), 371–376.

Cointegration

* Hayashi: chapter 10.

* Lütkepohl: chapters 6–8.

Hamilton: chapters 18–20.

Elliott, G. (1998). "The Robustness of Cointegration Methods when Regressors Almost Have Unit Roots." *Econometrica* 66(1), 149–158.

Watson, M. W. (1994). "Vector autoregressions and cointegration." In *Handbook of Econometrics, Volume IV*, edited by Engle, R. F., and McFadden, D. L., Elsevier, chapter 47, 2843–2915.

Long-run inference

Müller, U. K., and Watson, M. W. (2008). "Testing Models of Low-Frequency Variability." *Econometrica* 76(5), 979–1016.

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Applications

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