UNIVERSITY OF MARYLAND
Department of Economics

JOHN C. CHAO   **ECON 624**
INGMAR R. PRUCHA   Spring 2024

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	PRUCHA: Tydings Hall 3147A
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Lecture:	Tu/Th 12:30pm-1:45pm (TYD 2111)
	(if the course needs to be moved online, Zoom links will be provided)
Discussion:	Th 5:30-7:15pm (TYD 2111)
	(if the discussion session needs to be moved online, Zoom links will be provided)
Office Hours:	CHAO Th 3:30pm-5:30pm (and by appointment)
	PRUCHA Tu 2-4pm (and by appointment)

Course Website
Part A: Prof. Chao will upload his lecture slides onto ELMS (URL:elms.umd.edu). Problem sets and the take-home midterm exam will also be made accessible via ELMS.
Part B: Most course related material will be made available on Prof. Prucha's teaching web site.
 http://econweb.umd.edu/~prucha/econometricsIV_Part2.html.
 Please send an email to the teaching assistant for login/password information.

Course Communication
Part A: The easiest way to reach Prof. Chao is via the email address given above. The easiest way to reach TA Weizheng Lai is via the email address laiwz@umd.edu.
Part B: Prof. Prucha will use email as needed for course communication. The easiest way to reach TA Weizheng Lai is via the email address laiwz@umd.edu.

Emergency Protocol
In case the university closes for weather related or other emergencies, lectures will be held virtually by Zoom if feasible. Exams will also be conducted as remote Zoom session if physical locations on campus are unavailable during the announced exam times.

ECONOMETRICS II

COURSE DESCRIPTION

Part A of the course covers the following topics:
- Basic Asymptotic Theory for Dependent Processes
- Stationary Linear Time Series Models
- VAR's
- Estimation of DSGE models (if time permits)

Part B of the course discusses methods of inference for
- Classical Nonlinear Models: We give a general discussion of the consistency and asymptotic normality of M (maximum or minimum) - estimators. Subsequently we focus our discussion on the following leading cases: nonlinear least squares, maximum likelihood estimation and generalized method of moments estimation. We also discuss numerical optimization methods.
- Static and Dynamic Panel Data Models: We consider fixed effects and random effects specifications.
- If time permits, we will also discuss quantile regression, and non-parametric/ semi-parametric estimation methods.

COURSE AIMS

The course is oriented to provide students with a rigorous knowledge of classical econometric methods important for conducting empirical research in economics. The course will cover methods geared towards research in macro-economics, as well as methods geared towards research in micro-economics. The course is not geared towards training econometric theorists, although this course would be necessary training for such a specialization. In particular, the aim of the course is to provide students with knowledge appropriate to (i) read intelligently all empirical research (with a proper understanding of the underlying methodology of inference), and (ii) to conduct empirical research suitable for publication in **any** economics or econometrics journal.

ASSUMED REQUIREMENTS

Students are assumed to have knowledge of the fundamental concepts in probability and statistics at the level of textbooks by Casella and Berger, Statistical Inference, Duxbury Press, and Hogg, McKean and Craig, Introduction to Mathematical Statistics, Prentice Hall. They are furthermore assumed to have knowledge of the material covered in ECON 623, including basic knowledge of asymptotic theory. Students are also assumed to have a strong background in linear algebra and in the solution of difference equations.

PRINCIPAL TEXTS

Greene, W.A., *Econometric Analysis*, 7th edition, Prentice Hall, 2011.   (G)
Hamilton, J. *Time Series Analysis*, Princeton Univ. Press, 1994.   (H)
Hansen, B. *Econometrics*, Princeton Univ. Press, 2022.   (BH)

SUPPLEMENTARY TEXTS

Baltagi, B.H., Econometric Analysis of Panel Data, Wiley, 2013.   (B)
Wooldridge, J.M., Econometric Analysis of Cross Sectional Panel Data, MIT Press, 2010.   (W)

TOPICS

Part A: (required lit given below)
- Introduction to Time Series
- Basic Asymptotics of Time Series
- Analysis of Stationary Linear Time Series Models (Time domain)
- VAR's
- Bayesian VAR's (if time permits)
- MCMC, Estimation of DSGE models (if time permits)

Part B: (required lit given below)
　　　　Classical Nonlinear Models
　　　　Estimation of Panel Data Models
　　　　LAD and Quantile Regression

ADDITIONAL ECONOMETRICS TEXTS AND REFERENCES

In addition to the above texts, below is a list of additional texts that may be helpful as background reading.

PART A
- Anderson, T.W., The Statistical Analysis of Time Series, John Wiley & Sons, 1971.
- Brockwell, P.J. and R.A. Davis, Time Series: Theory and Methods, 2nd ed. Springer-Verlag, 1993.
- Davidson, J., Stochastic Limit Theory, Oxford University Press, 1994.
- Fuller, W. A., Introduction to Statistical Time Series, John Wiley & Sons, 1976.
- Hamilton, J., State Space Models, Handbook of Econometrics, Vol 4, Chapter 50, North Holland, 1994.
- Hannan, E.J. Multiple Time Series, John Wiley & Sons, 1970.
- Hannan, E.J. and M. Deistler, Statistical Theory of Linear Systems, John Wiley & Sons, 1988.
- Lutkepohl, H., New Introduction to Multiple Time Series Analysis, Springer, 2005.
- Tsay, R., Analysis of Financial Time Series, 3rd ed. John Wiley & Sons, 2010.

- Watson, M., Vector Autoregression and Cointegration, Handbook of Econometrics, Vol 4, Chapter 47, North Holland, 1994.

Part B

- Amemiya, T., Advanced Econometrics, Harvard University Press, 1985. (A)
- Arellano, M., Panel Data Econometrics, Oxford University Press, 2003.
- (AR)
- Bierens, H., Topics in Advanced Econometrics, Cambridge University Press, 1996.
- (B)
- Cameron, A.C., and P.K. Trivedi, Microeconometrics: Methods and Applications, Cambridge University Press, 2005. (C)
- Hsiao, C., Analysis of Panel Data, Cambridge University Press, 2014. (H)
- Poetscher, B.M., and I.R. Prucha, Dynamic Nonlinear Econometric Models, Springer Verlag, 1997. (P)
- Wooldridge, J., Econometric Analysis of Cross Section and Panel Data, MIT Press, 2010 (W).

A general list of econometrics texts is maintained on
http://econweb.umd.edu/~prucha/Handouts_General/Textbooks/Textbooks.pdf

GRADING POLICY

Parts A and B of Econ 624 will, respectively, be graded based on

Homework	15%*
Exam	35%**

* Homework problems will consist of theoretical problems and of computer problems. Homework needs to be handed in to the TA, on the specified due date. Homework problems that are handed in one day late lose 25 percent of the points they would otherwise have received. No points are awarded for home work that is more than one day late.

Instructions specific to Part A: Homework for Part A consists of three problem sets. Students are encouraged to work in groups but the final answer needs to be written down individually (not copied from someone else or from another source). Plagiarism rules apply to homework: if you are using source materials you need to cite the source. The purpose of the homework is to give you sufficient practice to learn the material, not to assess your knowledge of the material (this is done in the exam). It is important to invest enough effort in the problem sets while also balancing this with requirements for other courses.

** No makeup exams will be given except in cases of illness (confirmed by a doctor's certificate), religious observance, participation in University activities at the request of the University authorities, or compelling circumstances beyond the student's control. If at all possible, the student must inform us (or the Economics Department) of her/his situation before the exam.

In case the University is closed during (part of) the official scheduled time period for the final exam, the exam will be rescheduled according to the instructions that will be given by the University in that eventuality.

MIDTERM	The midterm will be a take-home exam to be uploaded onto ELMS on Friday, March 29, 2024 at 5pm and will be due on Tuesday, April 2, 2024 at 12:00 noon.
FINAL EXAM:	Thursday, May 16, 2024, 1:30-3:30pm, or alternatively take-home exam. More details will be provided at the beginning of part B of the course.

UNIVERSITY AND GRADUATE SCHOOL RULES AND REGULATIONS:

University policies can be found here: https://policies.umd.edu/
In particular:
- https://policies.umd.edu/general-administration/university-of-maryland-disability-accessibility-policy-and-procedures
- https://policies.umd.edu/general-administration/university-of-maryland-policy-and-procedures-on-sexual-harassment-and-other-sexual-misconduct
- https://policies.umd.edu/student-affairs/university-of-maryland-policy-on-excused-absence
- https://policies.umd.edu/research/university-of-maryland-intellectual-property-policy

All graduate school policies can be found here: https://gradschool.umd.edu/course-related-policies

In particular note the following items:

Academic Integrity

The student-administered University Honor Code and Honor Pledge (shc.umd.edu/code.html) prohibits students from cheating on exams, plagiarizing papers, submitting the same paper for credit in two courses without authorization, buying papers, submitting fraudulent documents and forging signatures. On every examination students must write by hand and sign the following pledge,

"I pledge on my honor that I have not given or received any unauthorized assistance on this examination or assignment."

Compliance with the code is administered by the Student Honor Council, which strives to promote a community of trust on the College Park campus.

University policy of the Code of Academic Integrity, including procedures that handle violations can be found here: https://president.umd.edu/administration/policies/section-iii-academic-affairs/iii-100a

Copyright Protection for Class Materials

The lecture class and all other course materials that exist in a tangible medium, such as written or recorded lectures, Power Point presentations, handouts and tests, problem sets and solutions, are copyright protected. Students may not copy and distribute such materials except for personal use and with the instructor's permission. Obtaining and using such materials from courses taught in previous years without the instructor's explicit permission constitutes a copy right breach. In addition, unauthorized use of video or audio recordings may be in violation of state and federal law.

Attendance

By signing up for this class you agree to exam formats, course requirements and timing of exams and due dates of work to be handed in. Attendance in all lectures is expected except when excused for health or other reasons permitted by university policies. Absences need to be reported by email to the teaching assistant at least one hour before class.

Health and Mask Mandates
Covid related policies: https://umd.edu/4Maryland

Students with Disabilities

UMD guarantees appropriate accommodations for students with disabilities. If you require accommodations, please contact me as soon as possible. If you need further clarification, the link to ADS is: https://www.counseling.umd.edu/ads/

COURSE EVALUATIONS

Students are encouraged to submit course evaluations through CourseEvalUM (www.courseevalum.umd.edu).

TEACHING ASSISTANT

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Office Hours: Monday 3:00-4:30PM

COURSE OUTLINE AND READING LIST FOR PART A

1. **Introduction to Dependent Processes and Some Basic Asymptotic Theory for Time Series**

   Davidson, Chapters 12-15
   Hamilton, Chapter 7
   Hansen, Chapter 14, Sections 1-16
   Brockwell/Davis, Chapter 1

2. **Analysis of Stationary Linear Time Series Models**

   Hamilton, Chapters 1-3, 5
   Hansen, Chapter 14, Sections 17-41
   Brockwell/Davis, Chapters 2, 3, 8-10
   - Andrews and Ploberger (1996), "Testing for Serial Correlation Against an ARMA(1,1) Process," Journal of the American Statistical Association 91: 1331-1342.
   - Breusch (1978), "Testing for Autocorrelation in Dynamic Linear Models," Australian Economic Papers 17: 534-355.
   - Godfrey (1978), "Testing Against General Autoregressive and Moving Average Error Models when the Regressors include Lagged Dependent Variables," Econometrica 46: 1293-1303.
   - Pötscher, B.M. (1990): "Estimation of Autoregressive Moving-Average Order Given an Infinite Number of Models and Approximation Of Spectral Densities," Journal of Time Series Analysis, Vol. 11, No 2, p.165-179.
   - Andrews (1991), " "Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation," *Econometrica*, 59, 817–858
   - Jansson, M. (2004), "The Error in Rejection Probability of SimpleAutocorrelation Robust Tests," *Econometrica*, 72, 937-946.
   - Newey, W.K. and K.D. West (1987), "A Simple Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica* 55, 703-708.
   - Sun, Y. (2013), "Heteroscedasticity and Autocorrelation Robust F Test Using Orthonormal Series Variance Estimator," *The Econometrics Journal*, 16, 1–26.
   - Sun, Y. (2014), "Let's Fix It: Fixed-*b* Asymptotics versus Small-*b* Asymptotics in Heteroskedasticity and Autocorrelation Robust Inference," *Journal of Econometrics* 178, 659-677.
   - Lazarus, E, Lewis, D.J. Stock, J.H. and Watson, M.W. (2016), "HAR Inference: Kernel Choice, Size Distortions, and Power Losses," manuscript.

3. **Vector Autogression (VAR)**

   - Hamilton, Chapters 10-12
   - Hansen, Chapter 15

- Lütkepohl, Chapters 2-5,9
- Tsay, Chapter 8, Sections 8.1-8.2
- Brockwell/Davis, Chapter 11
- Blanchard, O. and D. Quah (1989), The Dynamic Effects of Aggregate Demand and Supply Disturbances, American Economic Review, 655-672.
- Bernanke, B.S., and A.S. Blinder (1992), The federal funds rate and the channels of monetary transmission , American Economic Review 82(4):901-921.
- Baumeister, C. & Hamilton, J. D. (2015b). Sign Restrictions, Structural Vector Autoregressions, and Useful Prior Information. Econometrica 83(5), 1963–1999
- Canova, Fabio and Gianni De Nicolo (2002): "Monetary Disturbances Matter for Business Cycle Fluctuations in the G-7," Journal of Monetary Economics, 49, 1131-59.
- Christiano, L., M. Eichenbaum, and C. Evans (1999). Monetary policy shocks: What have we learned and to what end? Ch. 2 in J.Taylor and M. Woodford (ed.). In Handbook of Macroeconomics,Vol. 1A:65-148.
- Christiano, L., M. Eichenbaum, and R. Vigfusson, (2006), Assessing Structural VARs, manuscript.
- Chari, V.V., P.J. Kehoe and E.R. McGrattan (2007), Business Cycle Accounting, Econometrica 75, 781-836.
- Chari, V.V., P.J. Kehoe and E.R. McGrattan (2007), Are Structural VARs with Long-Run Restrictions Useful in Developing Business Cycle Theory? Federal Reserve Bank of Minneapolis Research Department Staff Report 364.
- Doan, T., R. Litterman, C. A. Sims (1984). "Forecasting and Conditional Projection Using Realistic Prior Distributions," *Econometric Reviews*, 3, 1-100.
- Engle, R. F., D. F. Hendry, and J.-F. Richard, (1983), Exogeneity, Econometrica, 51, 277-305.
- Faust, Jon (1998): "The Robustness of Identified VAR Conclusions about Money," Carnegie- Rochester Conference Series on Public Policy, 49, 207-244.
- 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.
- Hendry, D. F. (1995), Dynamic Econometrics, Oxford: Oxford University Press.
- Jordà, O (2005) "Estimation and Inference of Impulse Responses by Local Projections," American Economic Review, March.
- Killian, L. (1998), Small-sample confidence intervals for impulse response functions , Review of Economics and Statistics 80(2):218-230.
- Litterman, R. (1986). "Forecasting with Bayesian Vector Autoregression: Five Years of Experience," *Journal of Business and Economic Statistics*, 4, 25-38.
- Plagborg-Moller, M. (2016): "Bayesian Inference on Structural Impulse Response Functions", mimeo.
- Schorfheide, F. (2000). Loss function-based evaluation of DSGE models. Journal of Applied Econometrics 15(6):645--670.

- Sims, C.A.(1972), "Money, Income and Causality," American Economic Review 62: 540-552.
- Sims, C.A.(1980), "Macroeconomics and Reality," Econometrica 48: 1-48.
- Sims and Zha(1999), "Error Bands for Impulse Responses", Econometrica, vol 67, no. 5, pp 1113-1156
- Stock and Watson (2016), "Factor Models and Structural VARs in Macroeconomics", mimeo.
- Uhlig, Harald (2005): "What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure," Journal of Monetary Economics, 52, 381-419.

4. Estimation of DSGE Models

- An, S and F. Schorfheide (2007), Bayesian Analysis of DSGE Models, Econometric Reviews, 26: 113-172.
- Del Negro, M., and F. Schorfheide (2004). "Priors from General Equilibruim Models for VARs," *International Economic Review*, 45, 643-673.
- Del Negro, M., F. Schorfheide, F. Smets, and R. Wouters (2007). "On the Fit and Forecasting Performance of New Keynesian Models," *Journal of Business and Economic Statistics*, 25, 123-143.
- Fernandez-Villaverde, J. and J. Rubio-Ramirez (2005). "Estimating Dynamic Equilibrium Economies: Linear Versus Nonlinear Likelihood," *Journal of Applied Econometrics*, 20, 891-910.
- Schorfheide, F. (2000). Loss function-based evaluation of DSGE models. Journal of Applied Econometrics 15(6):645--670.

5. Structural Break

- Hamilton, Chapter 22
- Bai, J., Perron, P., 1998. Estimating and testing linear models with multiple structural changes. Econometrica 66, 47-78.
- Krämer, W., Ploberger, W., Alt, R., 1988. Testing for structural change in dynamic models. Econometrica 56, 1355-1369.
- Ploberger, W., Krämer, W., 1992. The CUSUM test with OLS residuals. Econometrica 60, 271-285.
- Ploberger, W., Krämer, W., Kontrus, K., 1989. A new test for structural stability in the linear regression model. Journal of Econometrics 40, 307-318.

COURSE OUTLINE AND TIMETABLE FOR PART B

I. CLASSICAL NONLINEAR MODELS
> (R)   Handout on "Classical Nonlinear Models"

1.   Consistency and Asymptotic Properties of M-Estimators
(2 lectures)
(R) A: Ch.4.1; P: Ch. 3,7,8; W: Ch. 12.1-12.3; Bierens: Ch. 4.2

2.   Nonlinear Least Squares
(2 lecture)
(R) A: 4.3; Bierens: Ch. 4.1, 4.3; G: Ch. 7

3.   Maximum Likelihood Estimation
(2 lectures)
(R) A: Ch. 4.2; P: Ch. 11.1; Bierens: Ch. 4.5; G: Ch. 14

4.   Generalized Method of Moments Estimation
(2lectures)
(R) P: Ch. 11.2; W: Ch. 14; G: Ch. 13

5.   Numerical Optimization Methods
(1 lectures)
(R) W: Ch. 12.7

II.   PANEL DATA MODELS
> (5 lectures)
> Fixed and random effects panel data models, dynamic panel data models, asymptotic properties.
> (R)   Handout on "Estimation of Panel Data Models"
>   References in handout.
>
> Prucha, I.R., On the Asymptotic Efficiency of Feasible Aitken Estimators for Seemingly Unrelated Regression Models with Error Components, Econometrica, 52(1), 1984, 203-207.
>
> Prucha, I.R., Maximum Likelihood and Instrumental Variable Estimation in Simultaneous Equation Systems with Error Components, International Economic Review, 26(2), 1985, 491-506.

III.   QUANTILE REGRESSION MODELS

(2 lectures)
Median and quantile regression, least absolute deviation estimator, two stage least absolute deviation estimators, asymptotic properties.

(R)   Handout on "Quantile Regression Models"
         References in handout.
Text: Koenker, R., Quantile Regression, Cambridge University Press, 2005.

IV.   NON-PARAMETRIC ESTIMATION

(2 lectures, if time permits)
Kernel methods, density estimation, regression
Texts:
      Li, Q., and Racine, S.R., Nonparametric Econometrics: Theory and
      Practice, Princeton University Press, 2006.
      Racine, J.S., Nonparametric Econometrics: A Primer, Now Publishers
      Inc., 2008.
      Yatchew, A., Semiparametric Regression for the Applied Econometrician,
      Cambridge University Press, 2003.