ECO 3400
TOPICS IN ECONOMETRICS

Department of Economics. University of Toronto
Winter 2023

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COURSE DESCRIPTION

This course deals with the following topics in advanced econometrics.

1. Nonparametric and Semiparametric Regression Models (1 week)
2. Structural Dynamic Discrete Choice Models (1 week)
3. Flexible Estimation of Structural Models (2 weeks)
4. Finite Dependence & Euler Equations in Structural Dynamic Discrete Choice Models (2 weeks)

5. Bayesian analysis and MCMC (2 weeks)
6. Empirical Bayes I (2 weeks)
7. Empirical Bayes II (2 weeks)

PREREQUISITES
ECO2400 and ECO2401

MEETINGS
We will have one meeting per week. Regular class time and location: **Fridays, 2-4pm. Location GE100. In some weeks we may have to switch lectures to other times due to crash with the Econometrics seminar. Announcement will be made in advance**

EVALUATION
The evaluation will be based on an original research paper that each student will submit by the end of the course. The paper should be related to some of the topics covered in the course, and its main contribution can be either empirical or methodological. The due date of the research paper is **April, 30, 2023**.

Topic 1: Nonparametric and Semiparametric Regression Models
Instructor: Adonis Yatchew
Outline
1. Overview of nonparametric and semiparametric regression
2. Estimation of nonparametric, partial linear and index models
3. Treatment of endogenous variables
4. Testing procedures, constrained estimation and shape similarity
5. Models where data on derivatives are available
6. Applications and estimation in R

References:

- Yatchew, A., 2003, Semiparametric Regression for the Applied Econometrician, Themes in Modern Econometrics, Cambridge University Press
- Newey W., 2013, "Nonparametric Instrumental Variable Estimation, American Economic Review", 103:3, 550-556.
- Hall, Peter and A. Yatchew 2007: "Nonparametric Estimation When Data on Derivatives are Available", Annals of Statistics, 35:1, 300-323.

Topic 3: Structural Dynamic Discrete Choice Models
Instructor: Eduardo Souza Rodrigues
Outline:

1. Introduction
2. Estimation of dynamic discrete choice models
3. Identification of model parameters
4. Identification of counterfactual outcomes

References:

- Aguirregabiria, V. (2010): "Another Look at the Identification of Dynamic Discrete Decision Processes: An application to Retirement Behavior," Journal of Business & Economic Statistics, 28(2), 201-218.
- Aguirregabiria, V., and P. Mira (2002): "Swapping the Nested Fixed-Point Algorithm: A Class of Estimators for Discrete Markov Decision Models," Econometrica, 70(4), 1519-1543.
- Aguirregabiria, V., and P. Mira (2007): "Sequential Estimation of Dynamic Discrete Games," Econometrica, 75(1), 1-53.
- Aguirregabiria, V., and J. Suzuki (2014): "Identification and Counterfactuals in Dynamic Models of Market Entry and Exit," Quantitative Marketing and Economics, 12(3), 267-304.
- Arcidiacono, P., and R. A. Miller (2011): "Conditional Choice Probability Estimation of Dynamic Discrete Choice Models With Unobserved Heterogeneity," Econometrica, 79(6), 1823-1867.
- Arcidiacono, P., and R. A. Miller (2020): "Identifying Dynamic Discrete Choice Models off Short Panels," Journal of Econometrics, 215(2), 473-485.
- Bajari, P., C. L. Benkard, and J. Levin (2007): "Estimating Dynamic Models of Imperfect Competition," Econometrica, 75(5), 1331-1370.
- Berry, S., and G. Compiani (2020): "An Instrumental Variables Approach to Dynamic Models," Discussion paper, Yale University.
- Hotz, V. J., and R. A. Miller (1993): "Conditional Choice Probabilities and the Estimation of Dynamic Models," Review of Economic Studies, 60(3), 497-529.
- Kalouptsidi, M., P. T. Scott, and E. Souza-Rodrigues (2017): "On the Non-identification of Counterfactuals in Dynamic Discrete Games," International Journal of Industrial Organization, 50, 362-371.
- Kalouptsidi, M., P. T. Scott, and E. A. Souza-Rodrigues (2021): "Identification of Counterfactuals in Dynamic Discrete Choice Models," Quantitative Economics, 12(2), 351-403.
- Kalouptsidi, M., P. T. Scott, and E. A. Souza-Rodrigues (2021): "Linear IV Regression Estimators for Structural Dynamic Discrete Choice Models," Journal of Econometrics, 222(1), 778-804.
- Kalouptsidi, M., Y. Kitamura, L. Lima, and E. Souza-Rodrigues (2022): "Counterfactual Analysis for Structural Dynamic Discrete Choice Models," Discussion paper, University of Toronto.
- Magnac, T., and D. Thesmar (2002): "Identifying Dynamic Discrete Decision Processes," Econometrica, 70(2), 801-816.
- Norets, A., and X. Tang (2014): "Semiparametric Inference in dynamic binary choice models," The Review of Economic Studies, 81(3), 1229-1262.
- Rust, J. (1987): "Optimal Replacement of GMC Bus Engines: an Empirical Model of Harold Zurcher," Econometrica, 55(5), 999-1033.
- Rust, J. (1988): "Maximum likelihood Estimation of Discrete Dontrol Processes," SIAM Journal on Control and Optimization, 26(5), 1006-1024.

- Rust, J. (1994): "Structural Estimation of Markov Decision Processes," Handbook of Econometrics 4, 4, 3081-3143.

Topic 3: Flexible Estimation of Structural Models

Instructor: Yao Luo

Abstract:
This topic surveys existing methods and introduces a new one for estimating structural models. A structural model builds on economic theory and describes how endogenous variables are related to a group of explanatory variables. Such relation is often an implicit function that depends on unknown parameters, which is costly to solve. Two-step methods avoid solving the model but rely on the performance of first-step estimation. This new method uses a sieve to approximate the solution and penalize the equilibrium condition.

References:

- Aguirregabiria V., 2019, "Empirical Industrial Organization: Models, Methods, and Applications"
- Luo, Y. & P. Sang, 2022, "Penalized Sieve Estimation of Structural Models".

Topic 4: Finite Dependence & Euler Equations in Structural Dynamic Discrete Choice Models

Instructor: Victor Aguirregabiria

Outline

1. Estimation of Dynamic Discrete Choice Models
2. Nested Fixed Point algorithm (NFXP) for MLE ….. [8]
3. Nested Pseudo Likelihood (NPL) for MLE …… [3]
4. Two-Step CCP method …….. [7]
5. Finite Dependence Property …….. [4], [5], and [6]
6. Euler Equations Representation …….. [1] and [2]
7. Estimation using Euler equations ……. [1] and [2]
8. Solution and counterfactuals using Euler equations …… [2] and [9]
9. Code and Applications

References:

[1] Aguirregabiria, V., and A. Magesan (2013): "Euler equations for the estimation of dynamic discrete choice structural models," Advances in Econometrics, 31, 3-44.
[2] Aguirregabiria, V., and A. Magesan (2019): "Solution and estimation of dynamic discrete choice structural models using Euler equations," manuscript. University of Toronto.
[3] Aguirregabiria, V. and P. Mira (2002): "Swapping the nested fixed-point algorithm: A class of estimators for discrete Markov decision models," Econometrica, 70, 1519-1543.
[4] Arcidiacono, P., and R. Miller (2011): "CCP estimation of dynamic discrete choice models with unobserved heterogeneity," Econometrica, 79, 1823-1867.
[5] Arcidiacono, P., and R. Miller (2019): "Nonstationary dynamic models with finite dependence." Quantitative Economics, 10(3), 853-890.

[6] Arcidiacono, P., and R. Miller (2020): "Identifying dynamic discrete choice models off short panels," Journal of Econometrics, 215(2), 473-485.

[7] Hotz, J., and R.A. Miller (1993): "Conditional choice probabilities and the estimation of dynamic models," Review of Economic Studies, 60, 497-529.
[8] Rust, J. (1994): "Structural estimation of Markov decision processes," in R. E. Engle and McFadden (eds.) Handbook of Econometrics Volume 4, North-Holland.
[9] Rust, J. (1996): "Numerical dynamic programming in economics," Handbook of Computational Economics, 1, 619-729.

Topic 5: Simulation Methods and Bayesian Analysis
Instructor: Martin Burda
Outline:

1. Simulation-based Approximation
2. Monte Carlo EM
3. Hamiltonian Sequential Monte Carlo (HSMC)
4. Nonparametric Mixture Models with HSMC
5. Bayesian Neural Networks and Machine Learning with HSMC

References:

- Bordes, L. and Chauveau, D. (2016) "Stochastic EM algorithms for Parametric and Semiparametric Mixture Models for Right-censored Lifetime Data", Computational Statistics, 31, 1513-1538.
- Billio, M. and M. Caporin (2009). A generalized dynamic conditional correlation model for portfolio risk evaluation. Mathematics and Computers in Simulation 79 (8), 2566 -- 2578.
- Blevins, J. (2016) "Sequential Monte Carlo Methods For Estimating Dynamic Microeconomic Models", Journal of Applied Econometrics, 31, 773-804.
- Burda, M. (2014). "Parallel Constrained Hamiltonian Monte Carlo for BEKK Model Comparison", Advances in Econometrics, 34, 155-179.
- Burda, M. (2015). Constrained Hamiltonian Monte Carlo in BEKK GARCH with Targeting, Journal of Time Series Econometrics, 7(1), 95-113, 2015.
- Burda, M. and C. J. Campbell (2023) Constrained Bayesian Neural Network for Monotonic Utility in Discrete Choice Modeling, working paper.
- Burda, M. and Daviet, R. (2022) Hamiltonian Sequential Monte Carlo with Application to Consumer Choice Behavior, Econometric Reviews, forthcoming.
- Burda, M. and J. M. Maheu (2012). Bayesian adaptively updated hamiltonian monte carlo with an application to high-dimensional BEKK GARCH models. Studies in Nonlinear Dynamics & Econometrics 17 (4), 345--372.
- Caporin, M. and M. McAleer (2012). Do we really need both BEKK and DCC? a tale of two multivariate GARCH models. Journal of Economic Surveys 26 (4), 736751.

- Creal, D. (2012) "A Survey of Sequential Monte Carlo Methods for Economics and Finance", Econometric Reviews, 31(3), 245-296.
- Herbst, E. and Schorfheide, F. (2014) Bayesian Inference for DSGE Models, available at http://edherbst.net/
- Jacquier, E., Nicholas G. Polson and Peter E. Rossi (2004) Bayesian Analysis of Stochastic Volatility Models with Fat-Tails and Correlated Errors, Journal of Econometrics, 122(1)
- Koop, G. Van Dijk, H., and J. Geweke (2013) The Oxford Handbook of Bayesian Econometrics, Oxford University Press
- McLachlan, G. and Krishnan, T. (2008) The EM Algorithm and Extensions, 2nd ed, Wiley.
- Miller, K. (2009) Lecture slides for CS 294: Practical Machine Learning, College of Engineering, University of California, Berkeley
- Moffa, G. and Kuipers, J. (2014) Sequential Monte Carlo EM for Multivariate Probit Models, Computational Statistics and Data Analysis 72, 252--272.
- Moon, H. R. and Frank Schorfheide (2012) Bayesian and Frequentist Inference in Partially Identified Models, Econometrica, 80(2).
- Neal, R. M. (2011). MCMC using Hamiltonian Dynamics. In S. Brooks, A. Gelman, G. Jones, and X.-L. Meng (Eds.), Handbook of Markov Chain Monte Carlo. Chapman & Hall / CRC Press.
- Orbanz, P. (2014) Lecture Notes on Bayesian Nonparametrics, Department of Statistics, Columbia University
- Rossi, P.E., Allenby, G. M., and McCulloch, R. (2005) Bayesian Statistics and Marketing, Wiley.
- Train, K. (2008) "EM Algorithms for Nonparametric Estimation of Mixing Distributions", Journal of Choice Modelling, 1(1), 40-69.

Topic 5: Empirical Bayes Method (4 weeks)

Instructor: Chris Walters, Jiaying Gu

Outline

1. Introduction to EB methods
2. Gaussian, Poisson, and duration mixture models
3. EB shrinkage and posterior distributions
4. Nonparametric EB
5. Connections to decision theory
6. Frontiers: computation, inference, and prediction
7. Teacher and school value-added
8. Employer-level labor market discrimination
9. Connections to other methods: multi-level/hierarchical models, machine
10. learning, multiple testing, ranking and classification

References:

- Angrist, Hull, Pathak, and Walters (2017), "Leveraging lotteries for school value-added: testing and estimation," Quarterly Journal of Economics, 132 (2), 871 – 919.
- Gilraine, Gu and McMillan (2022), "A new method for estimating teacher value-added," NBER working paper 27094.
- Gu and Koenker (2017), "Empirical Bayesball remixed: empirical Bayes methods for longitudinal data," Journal of Applied Econometrics, 32 (3), 575 – 599.
- Gu and Koenker (2022), "Invidious comparisons: ranking and selection as compound decisions," forthcoming Econometrica.
- Kline, Rose, and Walters (2022), "Systemic discrimination among large US employers," forthcoming Quarterly Journal of Economics.
- Koenker and Gu (2017), "REBayes: an R package for empirical Bayes mixture methods," Journal of Statistical Software, 82(1), 1 – 26.

- Koenker, R. & Mizera, I. (2014), 'Convex optimization, shape constraints, compound decisions, and empirical bayes rules', Journal of the American Statistical Association 109(506), 674–685.
- Efron, B. (2014), 'Two modeling strategies for empirical bayes estimation', Statistical science 29(2), 285.
- Efron, B. (2010), Large-Scale Inference: Empirical Bayes Methods for Estimation, Testing, and Prediction, Cambridge U. Press: Cambridge.

- Robbins, H. (1951), Asymptotically subminimax solutions of compound statistical decision problems, in 'Proceedings of the Berkeley Symposium on Mathematical Statistics and Probability', Vol. I, University of California Press: Berkeley, pp. 131–149.
- Robbins, H. (1956), An empirical Bayes approach to statistics, in 'Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability', Vol. I, University of California Press: Berkeley, pp. 157–163.

SCHEDULE OF LECTURES

WEEK	DATE	TOPIC
Week 1:	Fri. Jan. 13	Topic 1: Nonparametric & Semiparametric Regression
Week 2:	Fri. Jan. 20	Topic 2: Structural Dynamic Discrete Choice Models
Week 3:	Fri. Jan. 27	Topic 3: Flexible Estimation of Structural Models
Week 4:	Fri. Feb. 3	Topic 3: Flexible Estimation of Structural Models

Week 5:	Fri. Feb. 10	Topic 4: Finite Dependence & Euler Equations in Structural Dynamic Discrete Choice Models
Week 6:	Fri. Feb. 17	Topic 4: Finite Dependence & Euler Equations in Structural Dynamic Discrete Choice Models
	Fri. Feb. 24	Reading Week
Week 7:	Fri. Mar. 3	Topic 5: Simulation Methods and Bayesian Analysis
Week 8:	Fri. Mar. 10	Topic 5: Simulation Methods and Bayesian Analysis
Week 9:	Fri. Mar. 17	Topic 6: Empirical Bayes Method I
Week 10:	Fri. Mar. 24	Topic 6: Empirical Bayes Method I
Week 11:	Fri. Mar. 31	Topic 7: Empirical Bayes Method II
Week 12:	Fri. April 7	Topic 7: Empirical Bayes Method II