

SYLLABUS FOR DANISH GRADUATE PROGRAM IN ECONOMICS

IDENTIFICATION AND ESTIMATION OF DYNAMIC STRUCTURAL MODELS

Overview: This three day course explores relationships between economic theory, identification, estimation and econometric practice. It develops structural approaches for analyzing large cross sectional and longitudinal data sets, by exploiting restrictions derived from the equilibrium dynamic outcomes of economic theory. The empirical specifications are derived from the data generating processes of models of individual discrete and continuous optimization, Nash equilibrium in non-cooperative games and market microstructure, optimal contracts, as well as competitive equilibrium. We investigate empirical content, characterize identification, evaluate alternative estimators and testing procedures, as well as consider counterfactuals. Topics covered include individual lifecycle labor decisions such as job matching, job search, early career decisions, migration, lifecycle labor supply, fertility, home purchase, as well as multi-agent problems of hidden information, moral hazard and adverse selection in procurement contracts and executive labor markets, and the externalities associated with technological change.

Lectures and informal discussion: Classes meet for three consecutive days on the hour from 10:00AM through to 4:00 for 45 minutes, punctuated by 15 minute breaks, with an hour off for lunch at 1:00PM. I will be available for informal discussions between each class, at lunch time, and also after the six classes conclude for the day at 4:45PM.

Course material: To help students prepare for and digest the course the lecture notes and class schedule will be posted at my personal website before the course begins.

DYNAMIC DISCRETE CHOICE

1 Introduction

Aguirregabiria, V., and P. Mira (2010): "Dynamic Discrete Choice Structural Models: A Survey," *Journal of Econometrics*, 156, 38-67.

Arcidiacono, P. and P. Ellickson (2011): "Practical Methods for Estimation of Dynamic Discrete Choice Models", *Annual Review of Economics*, 3, 363-394.

Eckstein, Z. and K. Wolpin (1989): "The Specification and Estimation of Dynamic Stochastic Discrete Choice Models: A Survey," *The Journal of Human Resources*, 24, 562-598.

Miller, R. (1997): "Estimating Models of Dynamic Optimization with Microeconomic Data," in *Handbook of Applied Econometrics*, M. Pesaran and P. Schmidt, editors, Basil Blackwell, Vol. 2, 246-299.

Pakes, A. (1994): "The Estimation of Dynamic Structural Models: Problems and Prospects, Part II. Mixed Continuous-Discrete Control Models and Market Interactions," in *Advances in Econometrics: Proceedings of the 6th World Congress of the Econometric Society*, edited by J. Lafont and C. Sims, Chapter 5, 171-259.

Rust, J. (1994): "Structural Estimation of Markov Decision Processes," in *Handbook of Econometrics, Volume 4*, edited by R. Engle and D. McFadden. Amsterdam: Elsevier-North Holland, Chapter 51, 3081-3143.

Todd, P., M. Keane and K. Wolpin (2011): "The Structural Estimation of Behavioral Models: Discrete Choice Dynamic Programming Methods and Applications," in *Handbook of Labor Economics, Volume 4*, edited by O. Ashenfelter and D. Card. Elsevier, Chapter 4, 331-461.

2 Bayesian Learning and Job Matching

Arcidiacono, P. M. Aucejo, A. Maurel and T. Ransom (2016): "College Attrition and the Dynamics of Information Revelation," working paper.

Crawford, G. and M. Shum (2005): "Uncertainty and Learning in Pharmaceutical Demand," *Econometrica*, 73, 1137-1173.

Dillon E., and C. Stanton (2016): "Self-Employment Dynamics and the Returns to Entrepreneurship," working paper.

Hincapé, A. (2018): "Entrepreneurship over the Life Cycle," working paper.

James, J. (2011): "Ability Matching and Occupational Choice," working paper.

Miller, R. (1984): "Job Matching and Occupational Choice," *Journal of Political Economy*, 92, 1086-1020.

Pastorino, E. (2014): "Careers in Firms: Estimating a Model of Job Assignment, Learning, and Human Capital Acquisition," working paper.

3 Early Career Choices and Migration

Keane, M., and K. Wolpin (1997): "The Solution and Estimation of Discrete Choice Dynamic Programming Models by Simulation and Interpolation: Monte Carlo Evidence," *The Review of Economics and Statistics*, 76, 648-672.

Keane, M., and K. Wolpin (1997): "The Career Decisions of Young Men," *Journal of Political Economy*, 105, 473-522.

Kennan, J. and J. Walker (2011): "The Effect of Expected Income on Individual Migration Decisions," *Econometrica*, 79, 211-251.

Lessem, R. (2017): "Mexico-U.S. Immigration: Effects of Wages and Border Enforcement," *Review of Economic Studies*, forthcoming.

Llull, J. (2017): "Immigration, Wages, and Education: A Labor Market Equilibrium Structural Model", *Review of Economic Studies*, forthcoming.

Llull, J. and R. Miller (2015): "Internal Migration in Dual Labor Markets," working paper.

4 Conditional Independence

Aguirregabiria, V., and P. Mira (2007): "Sequential Estimation of Dynamic Discrete Games," *Econometrica*, 75, 1-54.

Arcidiacono, P., and R. Miller (2011): "Conditional Choice Probability Estimation of Dynamic Discrete Choice Model with Unobserved Heterogeneity," *Econometrica*, 79, 1823-1867

Hotz, V. and R. Miller (1993): "Conditional Choice Probabilities and Estimation of Dynamic Models," *The Review of Economic Studies*, 60, 497-529.

Rust, J. (1987): "Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher," *Econometrica*, 55, 999-1033.

5 Representation and Finite Dependence

Arcidiacono, P., and R. Miller (2011): "Conditional Choice Probability Estimation of Dynamic Discrete Choice Model with Unobserved Heterogeneity," *Econometrica*, 79, 1823-1867.

Arcidiacono, P. and R. Miller (2016): "Nonstationary Dynamic Models with Finite Dependence," working paper.

Hotz, V. and R. Miller (1993): "Conditional choice probabilities and estimation of dynamic models," *The Review of Economic Studies*, 60, 497-529

6 Identification

Aguirregabiria, V. (2005): "Nonparametric Identification of Behavioral Responses to Counterfactual Policy Interventions in Dynamic Discrete Choice Processes," *Economic Letters* 87, 393-398.

Arcidiacono, P. and R. Miller (2015): "Identifying Dynamic Discrete Choice Models off Short Panels," working paper.

Kalouptzidi, M., P. Scott and E. Souza-Rodrigues (2016): "Identification of Counterfactuals in Dynamic Discrete Choice Models," working paper.

Magnac, T. and D. Thesmar (2002): "Identifying Dynamic Discrete Decision Processes," *Econometrica*, 70, 801-816.

Norets, A. and X. Tang (2014): "Semi-parametric Inference in Dynamic Binary Choice Models," *The Review of Economic Studies*, 81, 1229-1262.

7 Female Labor Supply, Fertility Human Capital and Durable Goods

Gayle, G., A. Hincapie and R. Miller (2018): "Life Cycle Fertility and Human Capital Accumulation," working paper.

Hotz, V. and R. Miller (1988): "An Empirical Analysis of Life Cycle Fertility and Female Labor Supply," *Econometrica*, 56, 91-119.

Khorunzhina, N., and R. Miller (2017): "American Dream Delayed: Shifting Determinants of Homeownership," working paper.

Miller, R. and S. Sanders (1997): "Human Capital Development and Welfare Participation," *Carnegie Rochester Conference Series on Public Policy*, 46, 1-45.

Wolpin, K. (1984): "An Estimable Dynamic Stochastic Model of Fertility and Child Mortality," *Journal of Political Economy*, 92, 852-874.

8 CCP Estimators

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.

Altug, S. and R. Miller (1998): "The Effect of Work Experience on Female Wages and Labour Supply," *The Review of Economic Studies*, 65, 45-85.

Amemiya T. (1985): *Advanced Econometrics*, Harvard University Press.

Bugni, F. and T. Ura (2016): "Inference in Dynamic Discrete Choice Problems under Local Misspecification," working paper.

Hotz, V. and R. Miller (1993): "Conditional Choice Probabilities and Estimation of Dynamic Models," *Review of Economic Studies*, 60, 497-529.

Hotz, V., R. Miller, S. Sanders and J. Smith (1994): "A Simulation Estimator for Dynamic Models of Discrete Choice," *Review of Economic Studies*, 61, 265-289.

McFadden, D. (1989): "A Method of Simulated Moments for Estimation of Discrete Response Models Without Numerical Integration," *Econometrica*, 57, 995-1026.

Newey, W. (1984): "A Method of Moments Interpretation of Sequential Estimators," *Economic Letters*, 14, 201-206.

Pakes, A. and D. Pollard (1989): "Simulation and the Asymptotics of Optimization Estimators," *Econometrica*, 57, 1027-1057.

Pesendorfer, M., and P. Schmidt-Dengler (2008): "Asymptotic Least Square Estimators for Dynamic Games," *The Review of Economic Studies*, 75, 901-908.

9 Unobserved Heterogeneity Revisited

Arcidiacono, P., and R. Miller (2011): "Conditional Choice Probability Estimation of Dynamic Discrete Choice Model with Unobserved Heterogeneity," *Econometrica*, 79, 1823-1867.

Hu, Y. and M. Shum (2012): "Nonparametric Identification of Dynamic Models with Unobserved State Variables," *Journal of Econometrics*, 171, 32-44.

Kasahara, H., and K. Shimotsu (2009): "Nonparametric Identification and Estimation of Finite Mixture Models of Dynamic Discrete Choices," *Econometrica*, 77, 135-175.

CONTRACTS AND MARKETS

10 Pure Moral Hazard

Gayle, G., and R. Miller (2009): "Has Moral Hazard Become a More Important Factor in Managerial Compensation?" *American Economic Review* 99, 1740-69.

Margiotta, M., and R. Miller (2000): "Managerial Compensation and the Cost of Moral Hazard," *International Economic Review*, 41, 669–719.

11 Moral Hazard and Hidden Information

Gayle, G., and R. Miller (2015): "Identifying and Testing Models of Managerial Compensation," *The Review of Economic Studies*, 82, 1074-1118.

Gayle, G., C. Li, and R. Miller (2016): "Was Sarbanes-Oxley costly: Evidence from Optimal Contracting on CEO Compensation," working paper.

12 Moral Hazard and Costly Verification

Bertomeu, J., R. Miller, I. Marinovic and F. Varas (2017): "An Empirical Model of Long-Term Contracting with Manipulation," working paper.

DeMarzo, P., and Y. Sannikov (2006): "Optimal Security Design and Dynamic Capital Structure in a Continuous-Time Agency Model," *Journal of Finance*, 61, 2681–2724.

DeMarzo, P., and Y. Sannikov (2006): "Learning, Termination, and Payout Policy in Dynamic Incentive Contracts." *The Review of Economic Studies*, 84, 182–236.

Zakolyukina, A. (2017): "Measuring Intentional GAAP Violations: A Structural Approach," *Journal of Accounting Research*, forthcoming.

13 Procurement Contracts

Bajari, P., S. Houghton, and S. Tadelis (2014): "Bidding for Incomplete Contracts: An Empirical Analysis of Adaptation Costs," *American Economic Review* 104, 1288–1319.

Kang, K. and R. Miller (2016): "Winning by Default: Why is there so Little Competition in Government Procurement?" working paper.

Krasnokutskaya, E. and K. Seim (2011): "Bid Preference Programs and Participation in Highway Procurement Auctions," *American Economic Review* 101, 2653–2686.

14 Limit Order Markets

Hollifield, B., R. Miller and P. Sandas (2004): "Empirical Analysis of Limit-Order Markets," *The Review of Economic Studies*, 71, 1027-1063.

Hollifield, B., R. Miller, P. Sandas and J. Slive (2006): "Estimating the Gains from Trade in Limit-Order Markets," *Journal of Finance*, 61, 2753-2804.

Sandas, P. (2001): "Adverse Selection and Competitive Market Making: Empirical Evidence from a Limit Order Market," *Review of Financial Studies*, 14, 705–734.

15 Complete Markets

Altug, S. and R. Miller (1990): "Household Choices in Equilibrium," *Econometrica*, 58, 543-570.

Eichenbaum Hansen, L. and K. Singleton (1988): "A Time Series Analysis of Representative Agent Models of Consumption and Leisure Choice under Uncertainty," *The Quarterly Journal of Economics*, 103, 51–78.

Hansen, L. and K. Singleton (1982): "Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models," *Econometrica*, 50, 1269-1286.

Hansen, L. and K. Singleton (1984): ERRATA, *Econometrica*, 52, 267-268.

Miller, R. and H. Sieg (1997): "A Microeconomic Comparison of Household Behavior between Countries," *Journal of Business and Economic Statistics*, 15, 237-254.

Sieg, H. (2000): "Estimating a Dynamic Model of Household Choices in the Presence of Income Taxation," *International Economic Review*, 41, 637-668.

16 Human Capital, Nonseparable Preferences, and Screening in the Labor Market

Altug, S. and R. Miller (1998): "The Effect of Work Experience on Female Wages and Labour Supply," *The Review of Economic Studies*, 65, 45-85.

Gayle, G. and L. Golan (2012): "Estimating a Dynamic Adverse Selection Model: Labor-Force Experience and the Changing Gender Earnings Gap 1968-97," *The Review of Economic Studies*, 79, 227- 267.

17 Lifecycle Career Concerns

Gayle, G., L. Golan, and R. Miller (2012): "Gender Differences in Executive Compensation and Job Mobility," *Journal of Labor Economics*, 30, 829-872.

Gayle, G., L. Golan, and R. Miller (2015): "Promotion, Turnover and Compensation in the Executive Labor Market," *Econometrica*, 83, 2293-2369.

18 Technological Change and Growth

Hamilton, B., R. Miller, A. Hincapie and N. Papageorge (2018): "Innovation and Diffusion of Medical Treatment," working paper.