PSC 585: Dynamic Models – Structure, Computation, & Estimation

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By combining formal theory and statistical inference, structural models enable social scientists to conduct rich analyses of how institutions and public policy shape individual or collective decision-making. The structural approach to empirical research is particularly useful in settings where more traditional methods cannot be applied, such as when agents behave strategically or when we wish to predict the consequences of never-before-observed policy interventions. This course covers the fundamentals of structural estimation, traversing a complete gamut of applications: individual choice and strategic interaction, both static and dynamic. Depending on student interest, applications from political science, economics, and marketing will be considered, but emphasis will be placed on the methodology with the aim of helping students expand their research toolkit.

Prerequisites: Students are expected to have taken PSC 404, 405, 407, and 408, or equivalent graduate courses in another department. The dynamic games section of the course comes later in the semester and is self-contained, so that there is no loss of continuity by taking this course concurrently with PSC 584.

Computing: Structural models rarely admit estimation using canned routines in popular statistical software (e.g., SPSS, Stata). Familiarity with a programming language (e.g., Matlab, Python, R) is therefore indispensable for structural estimation. Students should be prepared to acquire the necessary programming skills for the course.

Grading:

- Class participation

- Assignments during the course of the semester

- Presentation of a paper from the reading list

- Presentation of a research proposal (20 minutes), accompanied by a written paper outline (due on 12/15)

Most of the course material will be presented in self-contained lecture notes. Two books, *Numerical Methods in Economics* by K. Judd and *Applied Computational Economics and Finance* by M. Miranda and P. Fackler, may prove useful and are available online via the University library. Referenced articles are available electronically via JSTOR or similar electronic sources. The content of the course is broken into four sections. In the highly unlikely case that time permits, we may consider additional topics.

SCHEDULE

Reading List: Below is a preliminary list of topics and readings for the course. Topic 0 covers background methodological debates, which students are encouraged to study ahead of time. We will cover the first four topics in detail as they showcase most of the key ideas and techniques underpinning the applications.

0. THE CAUSAL VERSUS STRUCTURAL DEBATE

- Heckman, J. J. (2000). Causal Parameters and Policy Analysis in Economics: A Twentieth Century Retrospective. *Quarterly Journal of Economics*, 115(1):45–97

- Deaton, A. (2010). Instruments, Randomization, and Learning about Development. *Journal of Economic Literature*, 48:424–455

- Heckman, J. J. and Urzúa, S. (2010). Comparing IV with structural models: What simple IV can and cannot identify. *Journal of Econometrics*, 156:27–37

- Imbens, G. W. (2010). Better LATE Than Nothing: Some Comments on Deaton (2009) and Heckman and Urzua (2009). *Journal of Economic Literature*, 48:399–423

- Angrist, J. D. and Pischke, J.-S. (2010). The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics. *Journal of Economic Perspectives*, 24(2):3–30

- Nevo, A. and Whinston, M. D. (2010). Taking the Dogma out of Econometrics: Structural Modeling and Credible Inference. *Journal of Economic Perspectives*, 24(2):69–82

- Rust, J. (2010). Comments on: "Structural vs. atheoretic approaches to econometrics" by Michael Keane. *Journal of Econometrics*, 156:21–24

1. AGGREGATE DISCRETE-CHOICE MODELS

- Berry, S. T. (1994). Estimating Discrete-Choice Models of Product Differentiation. *RAND Journal of Economics*, 25(2):242–262

- Berry, S., Levinsohn, J., and Pakes, A. (1995). Automobile Prices in Market Equilibrium. *Econometrica*, 63(4):841–890

- Nevo, A. (2000). A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand. *Journal of Economics & Management Strategy*, 9(4):513–548

- Dubé, J.-P., Fox, J. T., and Su, C.-L. (2012). Improving the Numerical Performance of Static and Dynamic Aggregate Discrete Choice Random Coefficients Demand Estimation. *Econometrica*, 80(5):2231–2267

- Judd, K. L. and Skrainka, B. S. (2011). High Performance Quadrature Rules: How Numerical Integration Affects a Popular Model of Product Differentiation. CEMMAP Working Paper CWP03/11

- Reynaert, M. and Verboven, F. (2014). Improving the performance of random coefficients demand models: The role of optimal instruments. *Journal of Econometrics*, 179:83–98

- Gandhi, A. and Houde, J.-F. (2016). Measuring Substitution Patterns in Differentiated Products Industries. Working Paper

2. DISCRETE GAMES, PARTIAL IDENTIFICATION

- Ciliberto, F. and Tamer, E. (2009). Market Structure and Multiple Equilibria in Airline Markets. *Econometrica*, 77(6):1791–1828

- Chernozhukov, V., Hong, H., and Tamer, E. (2007). Estimation and Confidence Regions for Parameter Sets in Econometric Models. *Econometrica*, 75(5):1243–1284

- Bajari, P., Hong, H., and Ryan, S. P. (2010). Identification and Estimation of a Discrete Game of Complete Information. *Econometrica*, 78(5):1529–1568

- Romano, J. P. and Shaikh, A. M. (2010). Inference for the Identified Set in Partially Identified Econometric Models. *Econometrica*, 78(1):169–211

- Andrews, D. W. K. and Shi, X. (2013). "Inference Based on Conditional Moment Inequalities". *Econometrica*, 81(2):609–666

- Pakes, A., Porter, J., Ho, K., and Ishii, J. (2015). Moment Inequalities and Their Application. *Econometrica*, 83(1):315–334

- Shi, X. and Shum, M. (2015). Simple two-stage inference for a class of partially identified models. *Econometric Theory*, 31(3):493–520

- Jia, P. (2008). What Happens When Wal-Mart Comes to Town: An Empirical Analysis of the Discount Retailing Industry. *Econometrica*, 76(6):1263–1316

- Canay, I. A. and Shaikh, A. (2017). Practical and theoretical advances for inference in partially identified models. In B. Honoré, A. Pakes, M. P. and Samuelson, L., editors, *Advances in Economics and Econometrics*, volume 2 of *Econometric Society Monographs*, pages 271–306. Cambridge University Press

- Andrews, D. W. K. and Soares, G. (2010). Inference for parameters defined by moment inequalities using generalized moment selection. *Econometrica*, 78(1):119–157

- Romano, J. P., Shaikh, A., and Wolf, M. (2014). A practical two-step method for testing moment inequalities. *Econometrica*, 82(5):1979–2002

- McKelvey, R. and Palfrey, T. (1995). Quantal response equilibria for normal-form games. *Games and Economic Behavior*, 10(1):6–38

3. DYNAMIC PROGRAMMING

- 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 control processes. *SIAM Journal on Control and Optimization*, 26(5):1006–1024

- 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 Mira, P. (2002). Swapping the nested fixed point algorithm: A class of estimators for discrete Markov decision models. *Econometrica*, 70(4):1519–1543

- Aguirregabiria, V. and Mira, P. (2010). Dynamic discrete choice structural models: A survey. *Journal of Econometrics*, 156(1):38–67

- Arcidiacono, P. and Miller, R. (2011). Conditional choice probability estimation of dynamic discrete choice models with unobserved heterogeneity. *Econometrica*, 79(6):1823–1867

- Hotz, V. and Miller, R. (1993). Conditional choice probabilities and the estimation of dynamic models. *Review of Economic Studies*, 60(3):497–529

- Hotz, V., Miller, R., Sanders, S., and Smith, J. (1994). A simulation estimator for dynamic modles of dsicrete choice. *Review of Economic Studies*, 61(2):265–289

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

- Imai, S., Jain, N., and Ching, A. (2009). Bayesian Estimation of Dynamic Discrete Choice Models. *Econometrica*, 77(6):1865–1899

- Kasahara, H. and Shimotsu, K. (2008). Pseudo-likelihood estimation and bootstrap inference for structural discrete Markov decision models. *Journal of Econometrics*, 146(1):92–106

- Kasahara, H. and Shimotsu, K. (2009). Nonparametric Identification of Finite Mixture Models of Dynamic Discrete Choices. *Econometrica*, 77(1):135–175

- Magnac, T. and Thesmar, D. (2002). Identifying dynamic discrete decision processes. *Econometrica*, 70(2):801–816

- Norets, A. (2009). Inference in Dynamic Discrete Choice Modles with Serially Correlated Unobserved State Variables. *Econometrica*, 77(5):1665–1682

- Santos, M. S. (2010). Consistency properties of a simulation-based estimator for dynamic processes. *Annals of Applied Probability*, 20(1):196–213

- Santos, M. and Rust, J. (2004). Convergence properties of policy iteration. *SIAM Journal on Control and Optimization*, 42(6):2094–2115

- Taber, C. (2000). Semiparametric identification and heterogeneity in discrete choice dynamic programming models. *Journal of Econometrics*, 96(2):201–229.

4. Dynamic Games

- Aguirregabiria, V. and Mira, P. (2007). Sequential estimation of dynamic discrete games. *Econometrica*, 75(1):1–53

- Pesendorfer, M. and Schmidt-Dengler, P. (2008). Asymptotic least squares estimators for dynamic games. *Review of Economic Studies*, 75(3):901–928

- Bajari, P., Benkard, C. L., and Levin, J. (2007). Estimating dynamic models of imperfect competition. *Econometrica*, 75(5):1331–1370

- Haile, P. A., Hortacsu, A., and Kosenok, G. (2008). On the empirical content of quantal response equilibrium. *American Economic Review*, 98(1):180–200

- Hu, Y. and Shum, M. (2013). Identifying Dynamic Games with Serially-Correlated Unobservables. In *Advances in Econometrics (Volume 31): Structural Econometric Models*. Emerald Publishing

- Jovanovic, B. (1989). Observable implications of models with multiple equilibria. *Econometrica*, 57(6):1431–1437

- Pakes, A., Ostrovsky, M., and Berry, S. (2007). Simple estimators for the parameters of discrete dynamic games (with entry/exit examples). *RAND Journal of Economics*, 38(2):373–399

- Pesendorfer, M. and Schmidt-Dengler, P. (2010). Sequential Estimation of Dynamic Discrete Games: A Comment. *Econometrica*, 78(2):833–842

- Reiss, P. (1996). Empirical models of discrete strategic choices. *American Economic Review*, 86(2):421–426

- Jia Barwick, P. and Pathak, P. (2015). The costs of free entry: an empirical study of real estate agents in Greater Boston. *RAND Journal of Economics*, 46(1):103–145

5. Applications

- Strömberg, D. (2008). How the Electoral College Influences Campaigns and Policy: The Probability of Being Florida. *American Economic Review*, 98(3):769–807

- Kawai, K. and Watanabe, Y. (2013). Inferring Strategic Voting. *American Economic Review*, 103(2):624–662

- Martin, G. J. (2014). The Informational Content of Campaign Advertising. Working Paper

- García-Jimeno, C. and Yildirim, P. (2015). Matching Pennies on the Campaign Trail: An Empirical Study of Senate Elections and Media Coverage. Working Paper

- Kawai, K., Toyama, Y., and Watanabe, Y. (2015). Voter Turnout and Preference Aggregation. Working Paper

- Martin, G. J. and Yurukoglu, A. (2017). Bias in Cable News: Persuasion and Polarization. *American Economic Review*, 107(9):2565–2599

- Kang, K. (2016). Policy Influence and Private Returns from Lobbying in the Energy Sector. *Review of Economic Studies*, 83(1):269–305

- Canen, N., Trebbi, F., and Jackson, M. O. (2017). Endogenous Networks and Legislative Activity. Working Paper

- Iaryczower, M. and Shum, M. (2012). The Value of Information in the Court: Get it Right, Keep it Tight. *American Economic Review*, 102(1):202–237

- Iaryczower, M. and Shum, M. (2013). Money in Judicial Politics: Individual Contributions and Collective Decisions. Working Paper

- Iaryczower, M., Shi, X., and Shum, M. (2016). Can Words Get in the Way? The Effect of Deliberation in Collective Decision-Making? *Journal of Political Economy*, Forthcoming

- López-Moctezuma, G. (2016). Sequential Deliberation in Collective Decision-Making: The Case of the FOMC. Working Paper

- Silveira, B. S. (2017). Bargaining with Asymmetric Information: An Empirical Study of Plea Negotiations. *Econometrica*, 85(2):419–452

- Buera, F. J., Monge-Naranjo, A., and Primiceri, G. E. (2011). Learning the Wealth of Nations. *Econometrica*, 79(1):1–45

- Weese, E. (2015). Political mergers as coalition formation: An analysis of the *Heisei* municipal amalgamations. *Quantitative Economics*, 6:257–307

- Acemoglu, D., García-Jimeno, C., and Robinson, J. A. (2015). State Capacity and Economic Development: A Network Approach. *American Economic Review*, 105(8):2364–2409

- Diermeier, D., Keane, M., and Merlo, A. (2005). A Political Economy Model of Congressional Careers. *American Economic Review*, 95(1):347–373

- Iaryczower, M., Lopez-Moctezuma, G., and Meirowitz, A. (2017). Career Concerns and the Dynamicsof Electoral Accountability. Working Paper

- Lim, C. (2013). Preferences and Incentives of Appointed and Elected Public Officials: Evidence from State Trial Court Judges. *American Economic Review*, 103(4):1360–1397

- Kawai, K. and Sunada, T. (2015). Campaign Finance in U.S. House Elections. Working Paper

- Lim, C. and Yurukoglu, A. (2016). Dynamic Natural Monopoly Regulation: Time Inconsistency, Moral Hazard, and Political Environments. *Journal of Political Economy*, Forthcoming

- Diermeier, D., Eraslan, H., and Merlo, A. (2003). A structural model of government formation. *Econometrica*, 71(1):27–70

- Francois, P., Rainer, I., and Trebbi, F. (2015). How Is Power Shared in Africa? *Econometrica*, 83(2):465–503

- Knight, B. (2005). Estimating the Value of Proposal Power. *American Economic Review*, 95(5):1639–1652

- Merlo, A. and Tang, X. (2012). Identification and estimation of stochastic bargaining models. *Econometrica*, 80(4):1563–1604