

Political Science 867
Spatial Modeling
Winter 2005

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12-1, F 2-4, and by appt.

Friday 11:00 – 1:00 CST

Course Description:

Many social science theories incorporate a spatial dimension, positing that units located near each other will be more likely to behave similarly than units located further apart. This coexistence of behavioral and locational similarity – what we term spatial autocorrelation – carries both substantive and methodological implications. Not surprisingly, these substantive and methodological concerns are intrinsically linked.

Spatial autocorrelation may be produced by behavioral diffusion, as the behavior of observed units directly influences the behavior of other units. Diffusion processes are drawing increasing interest among political scientists, and spatial models are well-suited for modeling these processes. Alternatively, spatial autocorrelation may exist merely because neighboring units have similar attributes that produce the behavior in which we are interested. Scholars have long recognized the substantive importance of distinguishing between these two sources of spatial dependence, and spatial models can help us to do so, providing insights into the behavioral processes producing our data. The methodological consequences of ignoring either of these sources of spatial autocorrelation (or of misdiagnosing the source) can be severe, potentially leading us to erroneous substantive inferences, even on non-spatial variables of interest.

Happily, recent advances in spatial data analysis and spatial econometrics (both of which will be covered in this course) now allow for a much richer consideration of the spatial dimensions of our theories than has previously been possible. These advances have combined with the increased availability of geo-coded data and the development of statistical packages for the analysis of spatial data to produce a burgeoning interest in and application of spatial models.

The course will begin by introducing students to spatial data and the opportunities and challenges that these data present for modeling social and political behaviors. Next, we will examine approaches for mapping spatial data and for determining whether our data exhibit spatial dependence. We will then examine strategies for modeling this spatial autocorrelation, and examine a variety of diagnostics that aid in distinguishing the form of spatial autocorrelation present in our data. Next, we will turn to spatial panel data models, an emerging frontier in spatial modeling in which exciting advances are currently being made. Finally, we will conclude by examining some advanced topics in spatial modeling including spatial discrete choice models and Bayesian approaches to spatial modeling.

Texts:*Required:*

- Haining, Robert. 1990. *Spatial Data Analysis in the Social and Environmental Sciences*. Cambridge: Cambridge University Press. (Denoted Haining 1990 in list of readings).
- Haining, Robert. 2003. *Spatial Data Analysis: Theory and Practice*. Cambridge: Cambridge University Press. (Denoted Haining 2003 in list of readings).

Recommended:

- Anselin, Luc, Raymond J.G.M. Florax, and Sergio J. Rey, eds. 2004. *Advances in Spatial Econometrics: Methodology, Tools, and Applications*. Berlin: Springer.
- Cressie, Noel A.C.. 1993. *Statistics for Spatial Data*. New York: Wiley.

Grading:

Grading will be based on three data analysis assignments (each worth 30% of your grade) and a class presentation of one of the articles or papers from the syllabus (worth 10% of your grade). Students will consult with the instructor before choosing the article or paper.

Statistical Packages:

We will be using two statistical packages during the course. We'll use GeoDa for mapping and to conduct tests for spatial autocorrelation. We'll be using the spdep package in R for spatial modeling. GeoDa, R, and spdep are all available as free downloads from the internet. GeoDa can be downloaded from the Center for Spatially Integrated Social Science's website at <http://www.csiss.org/clearinghouse/GeoDa/>. R can be downloaded from any of the mirror sites listed at <http://www.r-project.org/>. Spdep can also be downloaded from this address. Click on search (under R Project on the left) and type in spdep at the Google box on the next page to access the spdep package.

*January 21: Introduction to Spatial Data Analysis**Required:*

- Anselin, Luc, and Anil K. Bera. 1998. "Spatial Dependence in Linear Regression Models with an Introduction to Spatial Econometrics." In *Handbook of Applied Economic Statistics*, eds. Aman Ullah, and David E.A. Giles. New York: Marcel Dekker.
- Anselin, Luc. 2003. "An Introduction to EDA with GeoDa." Available at <http://sal.agecon.uiuc.edu/csiss/pdf/quicktour.pdf>
- Anselin, Luc. 2003. "An Introduction to Spatial Autocorrelation Analysis with GeoDa." Available at <http://sal.agecon.uiuc.edu/csiss/pdf/spauto.pdf>
- Haining 1990. Chapter 2.

Recommended:

- Anselin, Luc. 2003. "GeoDa 0.9 User's Guide." Available at <http://sal.agecon.uiuc.edu/csiss/pdf/geoda093.pdf>
- Anselin, Luc. 2003. "GeoDa 0.9.5-i Release Notes." Available at <http://sal.agecon.uiuc.edu/csiss/pdf/geoda095i.pdf>
- Baybeck, Brady, and Robert Huckfeldt. 2002. "Urban Contexts, Spatially Dispersed Networks, and the Diffusion of Political Information." *Political Geography* 21: 195-220.
- Cho, Wendy K. Tam. 2004. "Open Source Spatial Data Analysis." *The Political Methodologist* 12(2): 13-17.
- Haining 2003. Chapter 1.
- Starr, Harvey. 2002. "Opportunity, Willingness and Geographic Information Systems (GIS): Reconceptualizing Borders in International Relations." *Political Geography* 21: 243-261

*January 28: Tests for Global and Local Spatial Autocorrelation**Assignment 1: Due February 4**Required:*

- Haining, 1990, pp. 228-239.
- Haining, 2003, pp. 237-246.
- Anselin, Luc. 1995. "Local Indicators of Spatial Association – LISA." *Geographical Analysis* 27: 93-115.
- O'Loughlin, John. 2002. "The Electoral Geography of Weimar Germany: Exploratory Spatial Data Analyses (ESDA) of Protestant Support for the Nazi Party." *Political Analysis* 10(3): 217-243.

Recommended:

- Cliff, Andrew, and J. Keith Ord. 1973. *Spatial Autocorrelation*. London: Pion.
- Darmofal, David. 2005. "The Political Geography of Voter Participation in American Political Development." Manuscript.
- Getis, Arthur, and Jared Aldstadt. 2004. "Constructing the Spatial Weights Matrix Using a Local Statistic." *Geographical Analysis* 36(2): 90-104.
- Moran, P.A.P. 1948. "The Interpretation of Statistical Maps." *Journal of the Royal Statistical Society B* 10: 243-251.
- Moran, P.A.P. 1950. "Notes on Continuous Stochastic Phenomena." *Biometrika* 37(1/2): 17-23
- Openshaw, Stan, and Peter Taylor. 1979. "A Million or so Correlation Coefficients: Three Experiments on the Modifiable Areal Unit Problem." In *Statistical Applications in the Spatial Sciences*, ed. N. Wrigley. London: Pion.
- Ord, J. Keith, and A. Getis. 1995. "Local Spatial Autocorrelation Statistics: Distributional Issues and an Application." *Geographical Analysis* 27: 286-306.
- Shin, Michael, and John Agnew. 2002. "The Geography of Party Replacement in Italy, 1987-1996." *Political Geography* 21: 221-242.

February 4: Spatial Heterogeneity

Required:

- Anselin, Luc. 1990. "Spatial Dependence and Spatial Structural Instability in Applied Regression Analysis." *Journal of Regional Science* 30(2): 185-207.
- Kelejian, Harry H., and Dennis P. Robinson. 2004. "The Influence of Spatially Correlated Heteroskedasticity on Tests for Spatial Correlation." In *Advances in Spatial Econometrics: Methodology, Tools, and Applications*, eds. Luc Anselin, Raymond J.G.M. Florax, and Sergio J. Rey. Berlin: Springer.
- Longley, Paul A., and Carolina Tobon. 2004. "Spatial Dependence and Heterogeneity in Patterns of Hardship: An Intra-Urban Analysis." *Annals of the Association of American Geographers* 94(3): 503-519.

Recommended:

- Anselin, Luc, and Wendy K. Tam Cho. 2002. "Spatial Effects and Ecological Inference." *Political Analysis* 10(3): 276-297. (see also Comment by King and Reply by Anselin and Cho in the same issue).
- Casetti, Emilio. 1997. "The Expansion Method, Mathematical Modeling, and Spatial Econometrics." *International Regional Science Review* 20: 9-33.
- Calvo, Ernesto, and Marcelo Escolar. 2003. "The Local Voter: A Geographically Weighted Approach to Ecological Inference." *American Journal of Political Science* 47(1): 189-204.
- Geoghegan, Jacqueline, Lisa A. Wagner, and Nancy E. Bockstael. 1997. "Spatial Landscape Indices in a Hedonic Framework: An Ecological Economics Analysis Using GIS." *Ecological Economics* 23: 251-264.
- Jones, Kelvyn, and Nina Bullen. 1994. "Contextual Models of Urban House Prices: A Comparison of Fixed- and Random-Coefficient Models Developed by Expansion." *Economic Geography* 70(3): 252-272.

February 11: Modeling Spatial Dependence 1

Assignment 2: Due February 25

Required:

- Anselin, Luc. 2002. "Under the Hood: Issues in the Specification and Interpretation of Spatial Regression Models." *Agricultural Economics* 27: 247-267.
- Anselin, Luc. 2003. "An Introduction to Spatial Regression in R." Available at <http://sal.agecon.uiuc.edu/csiss/pdf/spdepintro.pdf>
- Anselin, Luc, and Sergio Rey. 1991. "Properties of Tests for Spatial Dependence in Linear Regression Models." *Geographical Analysis* 23: 112-131.

Bivand, Roger. "The spdep Package." 2004. Available at <http://cran.r-project.org/doc/packages/spdep.pdf>

Recommended:

Anselin, Luc, Anil K. Bera, Raymond Florax, and Mann J. Yoon. 1996. "Simple Diagnostic Tests for Spatial Dependence." *Regional Science and Urban Economics* 26(1): 77-104.

Dubin, Robin. 1988. "Estimation of Regression Coefficients in the Presence of Spatially Autocorrelated Error Terms." *The Review of Economics and Statistics* 70(3): 466-474.

Gimpel, James G., and Wendy K. Tam Cho. 2004. "The Persistence of White Ethnicity in New England Politics." *Political Geography* 23(8): 987-1008.

Haining, 2003. Chapter 9.

Kelejian, Harry H., and Dennis P. Robinson. 1992. "Spatial Autocorrelation: A New Computationally Simple Test With an Application to Per Capita County Police Expenditures." *Regional Science and Urban Economics* 22: 317-331.

Venables, W.N., D.M. Smith, and the R Development Core Team. 2004. "An Introduction to R: Notes on R: A Programming Environment for Data Analysis and Graphics." Available at <http://cran.r-project.org/>

February 18: Break (No Class)

February 25: Modeling Spatial Dependence 2

Assignment 3: Due March 11

Required:

Anselin, Luc. 2003. "Spatial Externalities, Spatial Multipliers, and Spatial Econometrics." *International Regional Science Review* 26(2): 153-166.

Beck, Nathaniel, Kristian Skrede Gleditsch, and Kyle Beardsley. 2004. "Space is More than Geography: Using Spatial Econometrics in the Study of Political Economy." Manuscript.

Cho, Wendy K. Tam. 2002. "Contagion Effects and Ethnic Contribution Networks." *American Journal of Political Science* 47: 368-387.

Recommended:

Kelejian, Harry H., and Ingmar R. Prucha. 1998. "A Generalized Spatial Two-Stage Least Squares Procedure for Estimating a Spatial Autoregressive Model with Autoregressive Disturbances." *Journal of Real Estate Finance and Economics* 17(1): 99-121.

Kelejian, Harry H., and Ingmar R. Prucha. 1999. "A Generalized Moments Estimator for the Autoregressive Parameter in a Spatial Model." *International Economic Review* 40(2): 509-533.

- Land, Kenneth C., and Glenn Deane. 1992. "On the Large-Sample Estimation of Regression Models with Spatial or Network-Effects Terms: A Two-Stage Least Squares Approach." *Sociological Methodology* 22: 221-248.
- Shin, Michael, and Michael D. Ward. 1999. "Lost in Space: Political Geography and the Defense-Growth Tradeoff." *Journal of Conflict Resolution* 43(6): 793-817.
- Villareal, Andres. 2002. "Political Competition and Violence in Mexico: Hierarchical Social Control in Local Patronage Structures." *American Sociological Review* 67(4): 477-498.

March 4: Spatial Models for Panel Data

Required:

- Elhorst, J. Paul. 2003. "Specification and Estimation of Spatial Panel Data Models." *International Regional Science Review* 26(3): 244-268.
- Gleditsch, Kristian S., and Michael D. Ward. 2000. "War and Peace in Space and Time: The Role of Democratization." *International Studies Quarterly* 44: 1-29.
- Franzese, Robert J., Jr., and Jude C. Hays. 2004. "Empirical Modeling Strategies for Spatial Interdependence: Omitted-Variable vs. Simultaneity Biases." Manuscript.

Recommended:

- Baltagi, Badi H., and Dong Li. 2004. "Prediction in the Panel Data Model with Spatial Correlation." In *Advances in Spatial Econometrics: Methodology, Tools, and Applications*, eds. Luc Anselin, Raymond J.G.M. Florax, and Sergio J. Rey. Berlin: Springer.
- Baltagi, Badi H., Seuck Heun Song, and Won Koh. 2003. "Testing Panel Data Regression Models with Spatial Error Correlation." *Journal of Econometrics* 117: 123-150.
- Driscoll, John C., and Aart C. Kraay. 1998. "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data." *The Review of Economics and Statistics* 80(4): 549-560.

March 11: Advanced Topics

Required:

- Beron, Kurt J., and Wim P.M. Vijverberg. 2004. "Probit in a Spatial Context: A Monte Carlo Analysis." In *Advances in Spatial Econometrics: Methodology, Tools, and Applications*, eds. Luc Anselin, Raymond J.G. Florax, and Sergio J. Rey. Berlin: Springer.
- Fleming, Mark M. 2004. "Techniques for Estimating Spatially Dependent Discrete Choice Models." In *Advances in Spatial Econometrics: Methodology, Tools, and Applications*, eds. Luc Anselin, Raymond J.G. Florax, and Sergio J. Rey. Berlin: Springer.
- Ward, Michael D., and Kristian Skrede Gleditsch. 2002. "Location, Location, Location: An MCMC Approach to Modeling the Spatial Context of War and Peace." *Political Analysis* 10: 244-260.

Recommended:

- Heagerty, Patrick, Michael D. Ward, and Kristian Skrede Gleditsch. 2002. "Windows of Opportunity: Window Subseries Empirical Variance Estimators in International Relations." *Political Analysis* 10: 304-317.
- Holloway, Garth, Bhavani Shankar, and Sanzidur Rahman. 2002. "Bayesian Spatial Probit Estimation: A Primer and an Application to HYV Rice Adoption." *Agricultural Economics* 27: 383-402.
- LeSage, J.P. 1997. "Bayesian Estimation of Spatial Autoregressive Models." *International Regional Science Review* 20: 113-129.
- MacNab, Ying C. 2003. "Hierarchical Bayesian Modeling of Spatially Correlated Health Service Outcome and Utilization Rates." *Biometrics* 59: 305-316.
- McMillen, Daniel P., and John F. McDonald. 2004. "Locally Weighted Maximum Likelihood Estimation: Monte Carlo Evidence and an Application." In *Advances in Spatial Econometrics: Methodology, Tools, and Applications*, eds. Luc Anselin, Raymond J.G.M. Florax, and Sergio J. Rey. Berlin: Springer.