

**University of Illinois, Urbana-Champaign**  
**Department of Agricultural and Consumer Economics**  
**Spring 2005**

**ACE 592 SE — Spatial Econometrics**

**Luc Anselin**

**Meet:** Mon, Wed 3:00-4:50 pm, 316N Mumford Hall  
Lab, Mon 3:00-4:50 pm, N120 Turner Hall

**Course Web Site:** <http://sal.agecon.uiuc.edu/courses/se/>

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**Office Hours:** Mon-Wed 11:30–12:30 pm and by appointment

**Prerequisite:** Econ 471, 472, or equivalent, or permission of instructor

**Credit:** 1 unit

**COURSE DESCRIPTION**

OBJECTIVES

*Spatial econometrics* is the collection of econometric methods specifically geared at dealing with problems of spatial dependence and spatial heterogeneity encountered in cross-sectional (and panel) data sets. The use of spatial econometric techniques is increasingly common in empirical work in economics. The main objective of the course is to expose you to state of the art methods of applied econometrics so that you can effectively incorporate spatial effects into your empirical research.

While the focus will be on *spatial* aspects, the types of methods covered have general validity in econometric practice. The course will include topics such as the specification of dependent stochastic processes, maximum likelihood, instrumental variables and general method of moments estimation and specification tests. Considerable attention will be paid to understanding the properties of the methods through computational experiments (simulation) and to being able to apply the spatial econometric techniques in empirical practice.

ORGANIZATION

The course will be organized as a seminar with more emphasis on your reading and laboratory work than on traditional lectures. The course will follow the same outline as in previous years, but considerably more laboratory time will be included. The time on

Monday is reserved for lab and discussion sessions, Wednesday will be the organized lectures.

The main goal of the class is for you to become familiar with the essential methodological and practical issues that distinguish spatial econometrics from the traditional econometric methods.

The course “requirements” involve three different tasks:

- review and discussion of an example of an application of spatial econometric methods in an **empirical** study, published in a **recent** article (5 page paper) – 20%
  - the recent paper should have appeared since 1995, be empirical, not include Anselin as an author, and must first be approved by me (a list of suggested sources is provided below).
- a small computer simulation exercise, involving some programming in **R**, in which you will compare the properties of tests or estimators for simulated data (5 page paper + tables) – 40%
- an empirical analysis of a spatial data set (either your own, or one of the sample data sets), going through model specification, base-line OLS, diagnostics for spatial effects, and spatial regression analysis, including a write up that interprets the substantive findings (5 page paper + tables) – 40%

The first task is to be individual, the two others can be carried out as a group of 2 (larger groups need express permission). Each of the tasks will include oral class presentation and discussion. If you elect to work in a group, both members of the group will receive the same grade. Specific deadlines for the assignments will be provided as the semester proceeds.

You are encouraged to use your own data for the third task. However, you must have your data set “approved” by me, to avoid any problems at the end.

### TEXTS, SOFTWARE AND READINGS

There is no text per se. I assume that you are familiar with intermediate econometrics at a level of Wooldridge (2002) *Econometric Analysis of Cross Section and Panel Data*, Greene (2000), *Econometric Analysis*, Ruud (2000), *An Introduction to Classical Econometric Theory*, or Davidson and MacKinnon (1993), *Estimation and Inference in Econometrics*. A number of background materials on spatial econometrics are listed below. Selected readings will be made available as pdf files on the class web site. All lecture notes, assignments and other supporting materials will be made available on the web at <http://sal.agecon.uiuc.edu/courses/se/>.

The main software tool for the class will be the open source **R** environment. You can obtain the latest version of **R** for any platform from <http://cran.r-project.org/>. The current

version is 2.0.1 (November 2004). You are strongly urged to install this on your own computer system (it is free). The binaries for a Windows platform are straightforward to install. For spatial regression analysis, you will need the “package” **spdep** by Roger Bivand (latest version 0.3.8 December 2004). You can download the binaries for Windows from the contributed packages list. You can also find out more about spatial analysis software in **R** from the **R-Geo** web site, hosted here at the ACE Spatial Analysis Laboratory: <http://sal.agecon.uiuc.edu/csiss/Rgeo/> . There are tutorials on the use of **R** for spatial analysis at [http://sal.agecon.uiuc.edu/stuff\\_main.php](http://sal.agecon.uiuc.edu/stuff_main.php) . Specifically, we will be using Anselin (2005). *Spatial Regression Analysis in R, A Workbook*.

Even though the focus of the course is on regression analysis, you should consider installing GeoDa for visualization and spatial weights manipulation. GeoDa is at [http://sal.agecon.uiuc.edu/geoda\\_main.php](http://sal.agecon.uiuc.edu/geoda_main.php) . It comes with a User’s Guide and some sample data sets. There are also tutorials at [http://sal.agecon.uiuc.edu/stuff\\_main.php](http://sal.agecon.uiuc.edu/stuff_main.php) .

#### *Selection of Empirical Paper to Review*

Select an empirical article (not a methodological article) from the reference lists included in the following two review articles (they are available as pdf files on the course web site).

- Anselin, Luc, Raymond Florax and Sergio Rey. 2004. Econometrics for Spatial Models: Recent Advances. In *Advances in Spatial Econometrics, Methodology, Tools and Applications*, L. Anselin, R. Florax and S. Rey (Eds.), pp. 1-25. Heidelberg: Springer-Verlag.
- Florax, Raymond and Arno Van Der Vlist. 2003. Spatial Econometric Data Analysis: Moving Beyond Traditional Models. *International Regional Science Review* 26: 223-243.

#### *Recent Journal Special Issues Devoted to Spatial Econometrics*

- *International Regional Science Review* 2003, 26 (3).
- *International Regional Science Review* 2003, 26 (2). Special Issue on Spatial Externalities.
- *Agricultural Economics* 2002, 27 (3).
- *Journal of Real Estate Economics and Finance* 1998, 17 (1).
- *International Regional Science Review* 1997, 20 (1/2).

#### *Selected General References on Spatial Econometrics*

- Anselin, Luc, Raymond Florax and Sergio Rey (Eds.). 2004. *Advances in Spatial Econometrics: Methodology, Tools and Applications*. Heidelberg: Springer-Verlag.
- Anselin, Luc. 2003. Spatial Externalities, Spatial Multipliers and Spatial Econometrics. *International Regional Science Review* 26, 153-166.

- Anselin, Luc. 2002. Under the Hood. Issues in the Specification and Interpretation of Spatial Regression Models. *Agricultural Economics* 27, 247-267.
- Anselin, Luc. 1988. *Spatial Econometrics, Methods and Models*. Boston: Kluwer Academic.
- Cressie, Noel. 1993. *Statistics for Spatial Data*. New York: Wiley.
- Anselin, Luc and Raymond Florax (Eds.). 1995. *New Directions in Spatial Econometrics*. Berlin: Springer-Verlag.
- Anselin, Luc and Anil Bera. 1998. Spatial Dependence in Linear Regression Models with an Introduction to Spatial Econometrics. In A. Ullah and D. Giles (Eds.), *Handbook of Applied Economic Statistics*, pp. 237–289. New York: Marcel Dekker.
- Anselin, Luc. 2001. Spatial Econometrics. In B. Baltagi (Ed.), *Companion to Econometrics*, pp. 310-330. Oxford: Basil Blackwell.

## TENTATIVE COURSE CONTENT (Subject to Change)

### **Introduction and Refresher**

- Overview and motivating examples
- Spatial autocorrelation
- Spatial autocorrelation statistics
- Spatial weights matrices (construction, properties, manipulation)
- Spatial lag operator

### **Specification of Models with Spatial Effects**

- Models for spatial heterogeneity
- Spatial process models
- Models for spatial dependence

### **Specification Testing**

- Spatial autocorrelation tests
- Tests against spatial AR/MA errors
- Tests against other spatial errors
- Tests against spatial lag
- Tests against higher order alternatives
- Specification-robust tests

### **Estimation**

- Properties of ML estimator
- ML estimator of spatial lag model
- ML estimator of spatial error model
- ML estimators for higher order models
- Spatial two stage least squares
- GM estimation of spatial error model
- GMM estimation of spatial error model

**Advanced Topics (as time permits)**

- Space-time models and space-time autocorrelation
- Spatial panel data models
- Latent variables with spatial dependence
- Spatial probit
- Spatial models for count variables