

Handout 1: Overview of Spatial Econometrics

The Various Models

Consider an unemployment rate study in the 48 contiguous US States plus Washington DC, n=49 observations.

Non-Spatial Model:

(1) $y = X\beta + \varepsilon$ (OLS) **Luc Anselin**

Same as $Y_i = B_0 + B_1x_1 + B_2x_2 + \dots + \varepsilon_i$, but written in more compact Matrix/Vector notation.

We will measure who “Neighbors” are with a Spatial Weights Matrix, **W**

Regions might be correlated with their neighbors in three different ways:

- A) The value of y in a region might impact (or be related to) the value of y in a neighboring region (*lag y*)
- B) The values of X 's in a region might affect (or be related to) the value of y in a neighboring region (*lag X*)
- C) The residuals ε might affect (or be related to) the residuals in a neighboring region (*spatial autocorrelation*)

(2) $y = \rho Wy + X\beta + WX\theta + u$, $u = \lambda Wu + \varepsilon$ (*Manski Model*)

*If $\theta = 0$ then Manski becomes the Kelejian-Prucha model

(3) $y = \rho Wy + X\beta + u$, $u = \lambda Wu + \varepsilon$

*Or if $\lambda = 0$, we get the Spatial Durbin Model (SDM) Lesage & Pace (2009)

(4) $y = \rho Wy + X\beta + WX\theta + \varepsilon$ Spatial Durbin

* If $\rho = 0$, then this becomes the Spatially Lagged X (SLX) Model

(5) $y = X\beta + WX\theta + \varepsilon$

*If $\theta=0$, then (4) degenerates into the spatial lag model

(6) $y = \rho Wy + X\beta + \varepsilon$ Spatial Lag, Spatial Autoregressive (SAR)

*If $\theta = -\rho\beta$, then (4) simplifies into the spatial error model (because $\lambda = \rho$ in this case).

The math below is probably not technically correct... but it gives you the intuition:

$$y = \rho Wy + X\beta + WX[\theta = -\rho\beta] + \varepsilon$$

$$y = \rho W[X\beta + \varepsilon] + X\beta + WX[-\rho\beta] + \varepsilon$$

$$y = \rho WX\beta + \rho W\varepsilon + X\beta + WX[-\rho\beta] + \varepsilon$$

(7) $y = X\beta + u$, $u = \lambda Wu + \varepsilon$, where $\varepsilon \sim i.i.d.$ Spatial Error (SEM)

More advanced Models:

Panel Data Models (including Dynamic Panel) (See Elhorst JGS 2012)

Multiple Weights Matrices (See LeSage and Pace 2011, Review of Regional Studies)

Spatial Hierarchical Models (Lacombe)

Probit/Logit/Tobit/Poisson

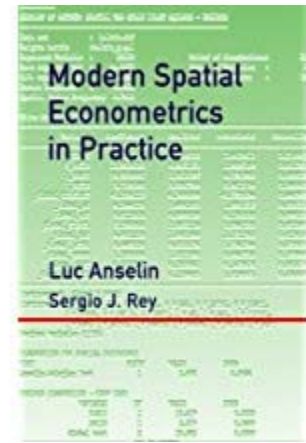
Critiques of Spatial Econometrics: <http://onlinelibrary.wiley.com/doi/10.1111/jors.2012.52.issue-2/issuetoc>

Handout 2: Some Sources for Reading:

Books:

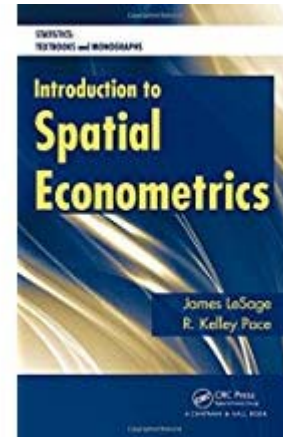
Luc Anselin and Sergio Rey: Modern Spatial Econometrics in Practice: A Guide to GeoDa, GeoDaSpace and PySAL (2014)

<https://www.amazon.com/Modern-Spatial-Econometrics-Practice-GeoDaSpace/dp/0986342106>



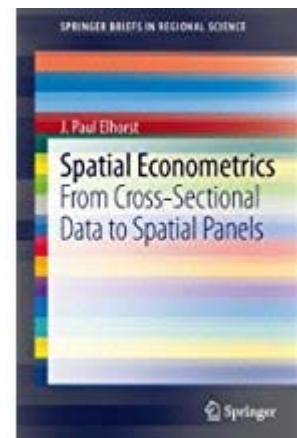
Lesage and Pace (2009) Introduction to Spatial Econometrics

<https://www.amazon.com/Introduction-Spatial-Econometrics-Statistics-Monographs/dp/142006424X>



Paul Elhorst: Spatial Econometrics: From Cross-Sectional Data to Spatial Panels 2014

<http://www.springer.com/us/book/9783642403392>



Good Overview Papers:

Lesage and Pace 2011: Pitfalls in Higher Order Model Extensions of Basic Spatial Regression Methodology <http://journal.srsa.org/ojs/index.php/RRS/article/view/39/205>

Lesage: What Regional Scientists Need to Know about Spatial Econometrics
<http://journal.srsa.org/ojs/index.php/RRS/article/view/44.1.2/pdf>

Elhorst Good overview (2010) :_Applied Spatial Econometrics: Raising the Bar

<http://rsa.tandfonline.com/doi/abs/10.1080/17421770903541772>

Elhorst: Dynamic spatial panels: models, methods, and inferences (2012)

<https://link.springer.com/article/10.1007/s10109-011-0158-4>

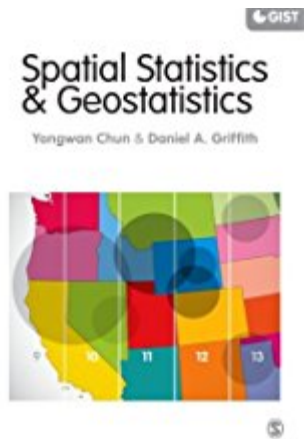
Handout 3: Software for Estimating Spatial Econometric Models

Two philosophies:

Spatial Statistics: Spatial interactions are “noise” that can be filtered out.

e.g., Chun and Griffith

Spatial Statistics and Geostatistics: Theory and Applications for Geographic Information Science and Technology



Spatial Econometrics: Spatial Interactions are interesting! Let's test/measure how they work!

Various Software Options

SAS, STATA, etc.

GEODA, GeoDaSpace Python (PySAL) <https://spatial.uchicago.edu/software>

(Anselin and Rey, others)

R (spdep package, others) (Roger Bivand, Luc Anselin, Gianfranco Piras, many others)

Matlab (Jim LeSage (Econometrics Toolbox), Paul Elhorst, Don Lacombe, many others)

Julia (Don Lacombe)