SSCI 574 Spatial Econometrics

Syllabus

Units: 4

Term – Day – Time: Spring 2021, Mondays 12 noon – 1:50 p.m. and Wednesdays 12 noon – 1:50 p.m. Pacific Time

Location: CPA 161 and Online (See the Blackboard course site for the Zoom link)

Instructor: An-Min Wu, PhD
Office: AHF B55B
Office Hours: Tuesdays, 11:30 a.m. – 12:30 p.m. and Thursday, 3 - 4 p.m. Pacific Time via zoom – please contact me via email in advance to ensure I will be online. Also available most days between 9 a.m. – 6 p.m. by appointment via email. A secured zoom meeting link will be sent to you via email when I confirm the appointment date/time.
Contact Info: anminwu@usc.edu

Library Help: Andy Rutkowski
Office: VKC B36B
Office Hours: By appointment
Contact Info: arutkows@usc.edu, 213-740-6390 (office), http://bit.ly/andyhangout

IT Help: Richard Tsung
Office: AHF B57E
Regular Office Hours: By appointment
Contact Info: ctsung@usc.edu

Course Description

This course explores the theoretical foundations, methods, techniques, and software systems for spatial econometrics. The course aims to provide students with the knowledge and skills necessary to investigate socioeconomic problems, with the consideration of the effects of spatial dependence and spatial heterogeneity. Essential concepts of spatial econometrics are presented, including the fundamental spatial concepts, spatial autocorrelation, and the core components of regression and spatial regression models for both cross-sectional and panel data. The latest research in a variety of topics using spatial econometric models is also examined. Students will gain an in-depth understanding and hands-on experience to explore a variety of applications through a combination of lectures, discussions, presentations, and projects. Students will learn about the variety of geospatial data and techniques available for solving socioeconomic challenges and problems.

This course serves as a required course for the Spatial Economics and Data Analysis M.S. Program and an elective course in the Geographic Information Science and Technology M.S. and Graduate Certificate Programs. Anyone wishing to pursue a career in solving social and built environment problems using spatial data analysis should gain an understanding of spatial statistics and spatial regression and therefore will be benefiting from this course. This course will be offered in a hybrid format. Lectures will be streamed for remote access at the beginning of the semester and will be also offered in person when in-person meetings are allowed on campus.

Learning Objectives

When you have completed this course, you will be able to:

- Articulate the key theoretical concepts of spatial econometrics and how spatial concepts can be used to produce new and better inferences in economics
- Describe the roles played by spatial dependence and spatial heterogeneity in solving social and economic problems.
- Analyze cross-sectional data using spatial regression methods in ArcGIS Pro, the GeoDa and R software environments.
- Enhance written and oral communication skills that are essential for today's workforce.

Prerequisite(s): SSCI 583 or by permission of the instructor
Co-Requisite(s): None

Class Conduct

Harassment, sexual misconduct, interpersonal violence, and stalking are not tolerated by the university. All faculty and most staff are considered Responsible Employees by the university and must forward all information they receive about these types of situations to the Title IX Coordinator. The Title IX Coordinator is responsible for assisting students with supportive accommodations, including academic accommodations, as well as investigating these incidents if the reporting student wants an investigation. The Title IX office is also responsible for coordinating supportive measures for transgender and nonbinary students such as faculty notifications, and more. If you need supportive accommodations you may contact the Title IX Coordinator directly (titleix@usc.edu or 213-821-8298) without sharing any personal

information with me. If you would like to speak with a confidential counselor, Relationship and Sexual Violence Prevention Services (RSVP) provides 24/7 confidential support for students (213-740-9355 (WELL); press 0 after hours)

Course Structure

This is a four-credit course that meets twice per week. The course will be delivered using multiple methods, including lectures, class presentations, discussion and hands-on practice. Exercises utilize unpublished and published materials using ArcGIS Pro, GeoDa, and R, with a focus in R, and project-based homework assignments allow students to demonstrate their ability to apply spatial statistical and econometric methods in an appropriate, informed manner. Student participation is encouraged through reading discussions, hands-on practices, homework assignments, and class presentations.

This is a graduate-level course, so you should expect this class to be intellectually challenging. As this is a four-credit course, students should expect to spend 10-15 hours per week completing the work in this course. As a graduate student, you are expected to engage with the information you are learning and to explore the ideas, opinion, and analysis that describe our collective effort to thoroughly interrogate the subject at hand. Learning arises from active engagement with the knowledge found in our reading materials and with one another. As in any graduate class, the instructor's role is that of a guide who keeps you on this path of discovery.

Technological Requirements

The course will be focused on using R as well as ArcGIS Pro and GeoDa for course assignments and hands-on practices in class. Both R and GeoDa are free, open-source software. The hands-on practices in class will be using R and RStudio (an integrated development environment for R), and therefore the installation of the software in your computer (PC or Mac) is preferred. All three of these software platforms can also be accessed via VMWare in the remote SSI Server. For weekly zoom class meetings and online access to SSI Server, every student must have the following:

- A computer with a fast Internet connection.
- A functional webcam and a microphone for use whenever a presentation or meeting is scheduled.

If a student does not have access to any of these, please speak with the instructor at the start of the semester to establish a workaround.

If you are unable to connect to the SSI Server or experience any type of technical issues relating to the server, send an email using your USC account to Tech Support at spatial_support@usc.edu; make sure to copy (c.c.) you instructor on the email. Questions pertaining to specific assignments should be directed to your instructor.

Communications – All course materials and correspondence will be posted on the course Blackboard website. Your quizzes, exam, and assignments will be graded and returned via Blackboard. In addition to email about time-sensitive topics, announcements will be posted on the Blackboard Announcement page. It is each student's responsibility to stay informed as to

course activities and updates. All students are in charge of ensuring that email sent from the USC Blackboard account is not directed to junk mail.

The instructor will endeavor to respond to email within 24 hours of receipt, aiming for no more than a 72-hour delay. An announcement will be posted in the rare instance when an instructor is offline for 72 hours or more.

Required Readings and Supplementary Materials

The required textbook for this course is:
- Chi, Guangqing, and Jun Zhu. 2019. *Spatial Regression Models for the Social Sciences*. Thousand Oaks, CA: SAGE Publications.

Supplementary readings will be assigned from various sources including:
- Anselin, L. 2019. The Moran scatterplot as an ESDA tool to assess local instability in spatial association. In *Spatial Analytical Perspectives on GIS*, pp. 111-126. Edited by Manfred Fischer, Henk J Scholten, and David Unwin. London: Routledge.

- Anselin, L. and Ray, S. 2014. Two stage least squares. In: *Modern Spatial Econometrics in Practice: A guide to GeoDa, GeoDaSpace, and PySAL*, pp. 139-142. GeoDa Press LLC.
- Arbia, G. 2014. The classical linear regression model. In: *A Primer for Spatial Econometrics: With Applications in R*, pp. 1-25. Palgrave Maximillian.
- 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*, pp. 283-295. Edited by Luc Anselin, R.J.G.M Florax, Sergio J. Rey. Berlin: Springer.
- Bivand, R. 2002. Spatial econometrics functions in R: Classes and methods. *Journal of Geographic Systems*, 4(4): 405-421.

- Celebioglu, Fatih, & Sandy Dall'erba. 2010. Spatial disparities across the regions of Turkey: an exploratory spatial data analysis. *Annals of Regional Science* 45(2): 379-400.

- Elhorst, J. Paul. 2014. Spatial panel data models. In *Spatial Econometrics from Cross-Sectional Data to Spatial Panels*, pp. 37-93. Berlin, Heidelberg: Springer.

- Elhorst, J. Paul. 2010. Applied spatial econometrics: raising the bar. *Spatial Economic Analysis* 5(1): 9-28.

- Fotheringham, A.S., Brunsdon, C., and Charlton, M. 2007. Statistical inference for spatial data. In: Fotheringham, A.S., Brunsdon, C., & Charlton, M. (eds.) *Quantitative Geography*. pp. 184-211. London: SAGE Publications Ltd.

- Fujita, M., Krugman, P. R., & Venables, A. 2001. *The spatial economy: Cities, regions, and international trade*. MIT press.

- Gibbons, Stephen, & Henry G. Overman. 2012. Mostly pointless spatial econometrics? *Journal of Regional Science* 52(2): 172-191.

- Harris, Nancy L., Elizabeth Goldman, Christopher Gabris, Jon Nordling, Susan Minnemeyer, Stephen Ansari, Michael Lippmann et al. 2017. Using spatial statistics to

identify emerging hot spots of forest loss. *Environmental Research Letters* 12(2): 024012.

- Kelejian, H.H., and Prucha, I.R. 2010. Specification and estimation of spatial autoregressive models with autoregressive and heteroskedastic disturbances. *Journal of Econometrics*, 157: 53-67.

- LeSage, J., and Pace, R.K. 2009. *Introduction to spatial econometrics*. Boca Raton, FL: CRC press.

- Livings, M. and Wu, A.-M. 2020. Local measures of spatial association. *The Geographic Information Science & Technology Body of Knowledge* (3rd Quarter 2020 Edition), John P. Wilson (Ed.)

- Lukongo, O. E., & Miller, T. 2018. Evaluating the Spatial Consequence of Interest Rate Ceiling Using a Spatial Regime Change Approach. *The American Economist*, 63(2), 166-186.

- Nilsson, P. 2014. Natural amenities in urban space–A geographically weighted regression approach. *Landscape and Urban Planning*, 121, 45-54.

- Pace, R. K. and Barry, R. 1997. Quick computation of spatial autoregressive estimators. *Geographic analysis*, 29: 232-247.

- Partridge, M.D., Boarnet, M., Brakman, S., and Ottaviano, G. 2012. Introduction: whither spatial econometrics? *Journal of Regional Science* 52(2): 167-171.

- Proost, S., & Thisse, J. F. 2019. What can be learned from spatial economics? *Journal of Economic Literature*, *57*(3), 575-643.

- Raudenbush, S.W., and Bryk, A.S. 2002. Hierarchical linear models: Applications and data analysis methods. Thousand Oaks, CA: Sage.

- Salvati, L. 2019. Examining urban functions along a metropolitan gradient: a geographically weighted regression tells you more. *Letters in Spatial and Resource Sciences*, 12(1), 19-40.

- Sparks, P.J., and Sparks, C.S. 2010. An application of spatially autoregressive models to the study of US county mortality rates. *Population, Space & Place* 16(6): 465-481.

- Tian, Lei, Wang, H. Holly., and Chen Yongjun. 2010. Spatial externalities in China regional economic growth. *China Economic Review* 21: S20-S31.

- Wu, A.-M., and Kemp, K.K. 2019. Global measures of spatial association. *The Geographic Information Science & Technology Body of Knowledge* (1st Quarter 2019 Edition), John P. Wilson (Ed.)

Description and Assessment of Assignments

Your grade in this course will be determined based on the basis of several different assessments:

Resume Assignment – 2 worth a total of 4 points. We require all current students to post and maintain a public resume, short biography and recent photo on our shared SSI Student

Community Blackboard site. Please prepare your resume in the SSI template that will be provided to you. Unless you opt out, your resume will be included in the Spatial Sciences Institute Graduate Programs Resume Book. This resume book is compiled annually and, along with our web presence, is used to promote our programs, and more importantly, your skills, experience and professional aspirations.

A second resume assignment is planned toward the end of the course so you can add the skills learned from this course to enhance your resume.

Lead Class Discussion – 1 worth a total of 10 points. These will focus on the theory portion of the course as presented in the weekly readings. Each student will be responsible for leading one class discussion on the assigned readings. The objective is to promote the students to evaluate and integrate the information from the course readings and enhance public presentation skills. Each student should plan for a 20-25-minute presentation and leading for class discussion with 2-3 questions from the presentation material following the presentation.

In-Class Work / Discussion - a total of 8 points. An in-class engagement grade for the semester will be assigned based upon student engagement for in-class activities. Students unable to join classes synchronously will be able to obtain the grades by joining the online discussion forum in the same week. The activities of in-class engagement can be, but not limited to, one-minute writing, group discussion, or hands-on practices. Failure to participate in in-class engagement activities will receive no grade for that week.

Quizzes – 5 worth a total of 20 points. There would be quizzes on the lectures and readings from the previous weeks. The top 5 score would be counted toward the final grade. There is no mid-term exam, so the quizzes are the assessment of how well the students have learned the material during the semester.

Projects – 4 worth a total of 28 points. Students will be assigned 4 project-based homework assignments during the course. The assignments include one research plan and four hands-on practices on spatial techniques explored in theory in the texts. The last project is to develop a Story Map with a case study of spatial statistics and spatial econometrics using the methods learned throughout the course. Students will present the last project's Story Map in the final presentation (see below).

Final Presentation – 1 worth a total of 10 points. A final presentation of the project Story Map will be delivered in the final week during the class session.

Final Exam – 1 worth a total of 20 points. A comprehensive final exam will be conducted during the final exam week following the university exam schedule.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Resume Assignments	2	2	4
Presentation/Lead Class Discussions	1	10	10
In-class Work / Discussion		8	8
Quizzes	5	4	20
Projects	4	7	28
Final Presentation	1	10	10
Final exam	1	20	20
Total	-	-	100

Assignment Submission Policy

Assignments must be submitted via Blackboard by the due dates specified in the Course Schedule below and on the assignment instructions. Unless otherwise noted, all assignments are *due by 11:59 pm Pacific Time (PT) on the due dates*. Your attention to on-time assignment submission is essential.

If you are physically located in a different time zones and have difficulty to join the live zoom sessions, please make sure to contact me in advance so I can arrange quizzes asynchronously.

Course Schedule: A Weekly Breakdown

	Topics	Readings and Assignments	Deliverables/Dues
Module 1: Overview of Spatial Economics and Spatial Econometrics			
Week 1 1/20* *Monday, 1/18 is university holiday	Introduction to course	Resume Assignment 1	Resume Assignment 1: due Friday, 1/22
Week 2 1/25 1/27	Introduction to spatial econometrics Urban economics overview	LeSage & Pace (2009) Ch1 Fujita et al. (2001) Ch 1-2 Proost & Thisse (2019)	Sign-up for lead class discussion
Week 3 2/1 2/3	Regional science overview Spatial statistics concept framework	Fujita et al. (2001) Ch3 Fotheringham et al. (2007) Ch8 Chi & Zhu (2019) Ch2 Project 1	In-class quiz

Module 2: Spatial Weights and Spatial Autocorrelation			
Week 4 2/8	Spatial weights matrix	Chi & Zhu (2019) Ch2 Bivand (2002) Wu & Kemp (2019)	
2/10	Global Measures of Spatial Association		
Week 5 2/17* *Monday, 2/15 is university holiday	Local Measures of Spatial Association	Anselin (2019) Harris et al. (2017) Celebioglu & Dall'erba. (2010) Livings & Wu (2020) Project 2	In-class quiz Submit Project 1 on the Blackboard no later than 5 p.m. on Tuesday, 2/16
Module 3: Non-Spatial Regression Models			
Week 6 2/22	Classic linear regression models	Arbia (2014) Ch1 Anselin & Ray (2014)	
2/24	Two step least squares (2SLS) & likelihood function		
Week 7 3/1	Maximum likelihood estimation (MLE)	Chi & Zhu (2019) Sec. 4.3 pp. 98-110 Raudenbush & Bryk (2002)	In-class quiz
3/3	Hierarchical linear modeling (HLE)		
Module 4: Spatial Regression Models			
Week 8 3/8	Motivation of regression for spatial econometrics models	LeSage and Pace (2014) Ch2 Pace and Barry (1997) Kelejian and Prucha (2010) Project 3	Submit Project 2 on the Blackboard no later than 5 p.m. on Tuesday, 3/9
3/10	Spatial autoregressive processes		
Week 9 3/15	Spatial lag models (SLM)	Chi & Zhu (2019) Ch3 Anselin (2003b) Elhorst (2010)	In-class quiz
3/17	Spatial error models (SEM)		
Week 10 3/22	Spatial Durbin models (SDM)	Chi & Zhu (2019) Ch3 pp.65 – 83 Resume assignment 2	Submit Resume Assignment 2 by Friday, 3/26
3/24	Models dealing with spatial heterogeneity		

		Module 5: Advanced Spatial Regression Methods		
Week 11 3/29 3/31	Geographically weighted regression Dealing with both spatial dependency and spatial heterogeneity: spatial regime models	Chi & Zhu (2019) Ch5 Nilsson (2014) Project 4	In-class quiz Submit Project 3 on the Blackboard no later than 5 p.m. on Tuesday, 3/30	
Week 12 4/5* *4/7 is a university Wellness Day	Spatial regime models (cont'd)	Chi & Zhu (2019) Ch6 Baltagi & Li (2004) Lukongo & Miller (2018)		
Week 13 4/12 4/14	Spatial panel model and other spatio-temporal analysis Problems and critiques of spatial econometrics models	Chi & Zhu (2019) Ch7 pp.155-167 Elhorst (2014) pp.37-53; 53-93 Gibbons & Overman (2012) Patridge et al. (2012)	In-class quiz	
Week 14 4/19 4/21	Practical applications of spatial econometric models Course review & summative discussion	Sparks & Sparks (2010) Tian et al. (2010)	Submit Project 4 on 11:59 p.m. on Friday, 4/23	
Week 15 4/26 4/28* *Thursday, 4/29 is last day of class	Project presentation I Project presentations II		Project presentations during class time	
Final Exam Week	Final Exam		Final exam follows the Final Exam Schedule	

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are

equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems

Counseling and Mental Health– (213) 740-9355 – 24/7 on call
engemannshc.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline – 1 (800) 273-8255 – 24/7 on call
 www.suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) – (213) 740-5086 |Title IX Compliance – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment– (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs – (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention – (213) 821-4710
uscsa.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC – (213) 740-2101
diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety – - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.

Resources for Online Students

The Course Blackboard page and the GIST Community Blackboard page have many resources available for distance students enrolled in our graduate programs. In addition, all registered students can access electronic library resources through the link https://libraries.usc.edu/. Also, the USC Libraries have many important resources available for distance students through the link: https://libraries.usc.edu/faculty-students/distance-learners. These include instructional videos, remote access to university resources, and other key contact information for distance students.