School of Economics

Academic Year 2024-25 Term 1

MSc in Economics

ECON6027: Spatial Econometrics and Data Analysis

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COURSE DESCRIPTION

This course includes concepts and tools used in econometric modelling and statistical analysis of spatial data: data on attributes that are **correlated in 'space/location'** (geo-tagged data). Spatial data are commonly used in regional science and urban economics (related to **property prices, crime, household income**, etc.), epidemiology and public health (such as **disease clusters**, etc.), environmental science (**air pollution, ozone density**, etc.), ecology, biology, geology, social interactions and network effects, and other disciplines.

We will start the course by looking at practical aspects of organising and visualising spatial data. We will also discuss how to use a **coordinate reference system** to give spatial awareness to a dataset and make meaningful **maps** including **animated and interactive maps using OpenStreetMap** and others. Then we will consider the statistical and econometric aspects behind spatial data analysis with a special focus on how to re-align classical statistical and econometric techniques towards spatial data for the three broad types of spatial data: (i) point patterns, (ii) areal data and (iii) geostatistical data.

Exploratory spatial data analysis methods, including various plots and tests for spatial autocorrelation, are discussed. Diagnostic tests for complete spatial randomness against spatial clustering or dispersion is a crucial step in the first stages of exploratory spatial data analysis. Point pattern analysis and different methods used to measure the degree of spatial autocorrelation will also be discussed. Spatial econometric models and estimation will be discussed in terms of areal data. Spatial econometric models and methods are effective in *modelling* spatial dependence and thus useful in predicting attributes that are affected/related to its' neighbours. We will focus on the main spatial regression methods (**spatial lag, spatial error, and spatial Durbin**) which are used to **build models** to explain attributes that are spatially correlated such as the number of **COVID cases**. The usual estimation techniques, quasi-maximum likelihood and GMM methods are discussed for model estimation and inferences. The course will end by discussing main methods of interpolation techniques such as **kriging** used in spatial data analysis.

Applications of these techniques **using R** will be presented throughout the course with real data. Knowledge of R programming is useful but not necessary.

Prerequisites include probability theory, inferential statistics, and econometrics at an undergraduate level.

LEARNING OBJECTIVES

Upon completion of this course, students should be able to use the most popular spatial statistical and econometric methods to organize, visualise, and analyse spatial data using R. The course also lays a holistic foundation for students who wish to explore spatial econometrics as a potential field of research.

LAPTOP

Students must bring a laptop computer to class for programming and data analysis.

PRE-REQUISITE/CO-REQUISITE/MUTUALLY EXCLUSIVE COURSES: None.

GRADED BASIS: Graded

COURSE UNIT: 1CU

COURSE AREA: Elective

ASSESSMENT METHODS

Class Participation	: 10%
Group Project	: 25%
Individual Assignments	: 25%
Final Examination	: 40%
Total	**: 100%**

ASSESSMENT DETAILS

- Class participation is based on attendance and your voluntary participation in the class discussions.
- The group project requires you to submit a report conducting a comprehensive point pattern analysis of a Singapore based attribute of your choice.
- Two individual assignments (of equal weight) after the conclusion of material in Weeks 4 and 8 respectively.
- Final exam is computer based, three hours and open book.

CLASS TIMINGS

TBA.

The course forms ten 3-hour sessions. Each session will include a lecture and an empirical illustration using R. All relevant R codes will be provided.

RECOMMENDED TEXTS AND READINGS

No single textbook covers all listed chapters above. The lecture notes I supply will cover all examinable material. If you need to read more, I recommend you look for the relevant chapters in the following references (the **titles in bold** are recommended and available in the library). Other references of relevant academic papers will be given in each chapter (where applicable).

For Theory:

- **Spa*tial Analysis with R*** by Tonny Oyana, 2nd edition, (2021).
- ***A Primer for Spatial Econometrics with Applications in R*** by Guiseppe Arbia, 1st edition, (2014).
- ***Introduction to Spatial Econometrics*** by James P. LeSage and R. Kelly Pace. Boca Raton: Taylor and Francis, 1st edition, (2009).
- *Spatial Econometrics: Methods and Models* by Luc Anselin. Dordrecht: Kluwer. (1988)
- *Statistical Methods for Spatial Data Analysis* by Oliver Schabenberger and Caro A. Gotway, 1st edition, (2005).

For *R*:

- Robin Lovelace, Jakub Nowosad, Jannes Muenchow (2019), ***Geocomputation with R***, 1st edition, CRC Press. Click here for the updated online version. 2nd edition of this title is forth-coming. Click here for the Python version of the same title.
- Paula Moraga (2023), ***Spatial Statistics for Data Science: Theory and Practice with R,*** 1st edition, CRC Press. Click here for the updated online version.

ACADEMIC INTEGRITY

All acts of academic dishonesty (including, but not limited to, plagiarism, cheating, fabrication, facilitation of acts of academic dishonesty by others, unauthorized possession of exam questions, or tampering with the academic work of other students) are serious offences.

All work (whether oral or written) submitted for purposes of assessment must be the student's own work. Penalties for violation of the policy range from zero marks for the component assessment to expulsion, depending on the nature of the offense.

When in doubt, students should consult the instructors of the course. Details on the SMU Code of Academic Integrity may be accessed at http://www.smuscd.org/resources.html.

ACCESSIBILITY
SMU strives to make learning experiences accessible for all. If students anticipate or experience physical or academic barriers due to disability, please let the instructor know immediately. Students are also welcome to contact the university's disability services team if they have questions or concerns about academic provisions: included@smu.edu.sg.

Please be aware that the accessible tables in the seminar room should remain available for students who require them.

EMERGENCY PREPAREDNESS FOR TEACHING AND LEARNING (EPTL)
Where there is an emergency that makes it infeasible to have classes on campus, classes will be conducted online via WebEx or other online learning platforms, with no disruption to the schedule. To familiarise students with the relevant platform, part of this course may be conducted online. The instructor will inform students of which classes, if any, will be conducted as part of this EPTL initiative.

ASSESSMENTS
Faculty have been instructed not to reuse questions verbatim from past year papers or published test banks, for the graded continuous assessments and examinations in this course.

WEEKLY LESSON PLAN

Week No	Topic	Readings
1	**Introduction to spatial data and managing spatial data in R:** giving spatial awareness to datasets; R ecosystem for handling geo-referenced datasets.	TBA
2	**Managing spatial data in R:** coordinate reference systems	TBA
3	**Cartography**: the ancient art of making maps!	
4	**Spatial descriptive summary measures:** spatial mean; spatial median; standard distance; standard deviational ellipse; empirical illustrations.	TBA
5	**Engaging in point pattern analysis:** clustering vs. dispersion; quadrat count analysis; kernel density estimation; K-function analysis; Clark and Evans Aggregation Index; empirical illustrations.	TBA
6	**Engaging in areal data analysis**: spatial neighbours; spatial weights matrix. measure spatial autocorrelation; join count analysis; Moran's I and Geary's C statistics.	TBA
	R E C E S S	
7	**Spatial linear regression models 1:** spatial lag, spatial error, and spatial Durbin models; estimation and inference; empirical illustrations.	TBA
8	**Spatial linear regression models 2:** spatial lag, spatial error, and spatial Durbin models; estimation and inference; empirical illustrations.	TBA
9	**Engaging in geospatial data analysis:** interpolation techniques; nearest neighbour interpolation, Voronoi tessellations and inverse distance interpolation; empirical illustrations.	TBA
10	**Engaging in geospatial data analysis:** semi-variance and kriging; empirical illustrations.	TBA
	Final Exam	