School of Economics

Academic Year 2022-23
Term 1

COURSE CODE & COURSE TITLE: ECON747 Spatial Econometric Models and Methods

Instructor Name : Yang Zhenlin
Email : zlyang@smu.edu.sg
Office : 50-69, School of Economics
Tel : 6828 0852
Website : http://www.mysmu.edu/faculty/zlyang/

1. Course Description

Spatial econometrics consists of econometric techniques dealing with empirical problems (in regional science, economics, and social sciences) where "interactions" among geographical units, economic agents or social actors generate "spatial dependence" among cross-section units rendering classical econometric techniques invalid. Common spatial effects such as, neighbourhood effects, spillover effects, copy-catting, networks effects, and externalities, have received an increasing attention by applied researchers. Spatial econometric models and methods have been proved to be very effective tools in dealing with these issues. Applications are seen not only in specialized fields of regional science, urban economics, real estate and economic geography, but also increasingly in more traditional fields of economics and finance, including demand analysis, labour economics, public economics, international economics, agricultural and environmental economics, asset pricing model, and arbitrage pricing theory.

Spatial econometric models extend classical econometric models by incorporating **spatial lag**, **spatial error**, and/or **spatial Durbin** terms to capture spatial dependence through spatial weight matrices and spatial coefficients. This course introduces the core set of spatial econometric models including spatial linear regression models, spatial panel data models, and spatial dynamic panel data models, and the associated methods of estimation and inference such as (quasi) maximum likelihood, M-estimation, and GMM. Common tests for spatial and/or dynamic effects, e.g., LM tests, standardized LM tests, and bootstrap LM tests are introduced. **Empirical illustrations** of the methods are presented using **Matlab software**.

2. Learning Objectives

The main learning objective of the course is to gain a set of state-of-the-art spatial econometric tools important in solving applied research problems where interactions among spatial units matter. The course focuses on the spatial models and methods with empirical illustrations. Upon completion of the course, students should be able to identify and formally test the possible existence of spatial dependence in the empirical studies they face, and be able to apply suitable spatial econometric models and methods learnt from the class to address issues related to spatial dependence, social interaction, social network, etc. As spatial econometrics is a fast-growing field with many problems remaining open, this course also serves as a channel for students to find suitable research topics for their PhD programs.

3. Pre-requisite/Co-requisite/Mutually Exclusive Course(s)

ECON611 Econometrics I and/or ECON726 Panel Data Econometrics I, or equivalent, are essential. Knowledge of Matlab programming is useful but not required.

4. Assessment Methods

Assessment Categories	Weightage (%)
Class Participation	10
Assignments	30
Midterm Test	20
Research Paper	40
Total	**100**

5. Course Assessment Details

- **Class participation:** This is to encourage students to be attentive in classes (Thur. 3:30-6:45pm, 18 Aug to 17 Nov, 2022) and to actively engage in class discussions. The course comprises twelve 3-hour sessions. Each session will include a lecture and an empirical illustration using Matlab. All relevant Matlab codes will be provided.
- **Assignments:** There will be five (5) assignments of 6 marks each. The main purpose of the assignments is to ensure a proper understanding of the course materials and the basic skills for empirically implementing the spatial methods being picked up.
- **Midterm test:** It will be an open-book and take-home test, which will occur between Sessions 6 and 7. The main purpose of the midterm test is to ensure that the fundaments delivered in the first four lectures are well taken.
- **Research paper:** The research paper fits the nature of the course: ART (Advanced Research Topic). The main purpose is to train students to write academic papers. The key components in assessment are the quality of the paper and the quality of the oral presentation at the end of the term (see "Instructions to Research Paper").

6. Recommended Text and Readings

No single textbook covers all listed chapters in the "Weekly Lesson Plan" given below. The lecture notes constitute the main readings for the course, where each "Lecture" draws from one or two key papers listed below. Lecture 1, recommended textbooks, and Papers 1 and 2 provide fundamentals on spatial econometrics and are ideal for initial readings. The state-of-the-art spatial econometric methods are covered in the subsequent Lectures and papers.

Recommended Textbooks

- Anselin, Luc (1988). **Spatial Econometrics: Methods and Models**, (Dordrecht: Kluwer).
- Elhorst P. J. (2014). **Spatial econometrics: from Cross-Sectional Data to Spatial Panels**, Heidelberg: Springer.
- LeSage, J. P. and R. K. Pace (2009). **Introduction to Spatial Econometrics**, Boca Raton: Taylor and Francis.

Key Papers

1. Anselin, L. and Bera, A. K. (1998). Spatial dependence in linear regression models with an introduction to spatial econometrics. In: *Handbook of Applied Economic Statistics*, edited by Aman Ullah and David E. A. Giles}. New York: Marcel Dekker
2. Anselin, L. (2001). Spatial Econometrics. In: *A Companion to Theoretical Econometrics*, edited by Badi H. Baltagi. Blackwell Publishing.

3. Lee, L. F. (2004). Asymptotic distributions of quasi-maximum likelihood estimators for spatial autoregressive models. ***Econometrica* 72**, 1899-1925.
4. Liu, S. F. and Yang, Z. L. (2015a). Asymptotic distribution and finite-sample bias correction of QML estimators for spatial error dependence Model. ***Econometrics* 3**, 376-411.
5. Baltagi, B. H. and Yang, Z. L. (2013a). Standardized LM tests for spatial error dependence in linear or panel regressions*.* ***Econometrics Journal* 16**, 103-134.
6. Baltagi, B. H. and Yang Z. L. (2013b). Heteroskedasticity and non-normality robust LM tests of spatial dependence. ***Regional Science and Urban Economics* 43,** 725-739.
7. Liu, S. F. and Yang, Z. L. (2015). Modified QML estimation of spatial autoregressive models with unknown heteroskedasticity and normality. ***Regional Science and Urban Economics*, 52,** 50-70.
8. Yang, Z. L. (2015a). A general method for third-order bias and variance correction on a nonlinear estimator. ***Journal of Econometrics*, 186**, 178-200.
9. Liu, S. F., Yang, Z. L. (2015b). Improved Inferences for Spatial Regression Models. ***Regional Science and Urban* Economics 55**, 55-67*.*
10. Yang, Z. L. (2015b). LM tests of spatial dependence based on bootstrap critical values. ***Journal of Econometrics* 185**, 33-39*.*
11. Lee, L. F. and Yu, J. (2010). Estimation of spatial autoregressive panel data models with fixed effects. ***Journal of Econometrics* 154**, 165-185.
12. Yang, Z. L., Yu, J. H, and Liu, S. F. (2016). Bias correction and refined inferences for fixed effects spatial panel data models. ***Regional Science and Urban Economics* 61**, 52-72*.*
13. Liu, S. F. and Yang, Z. L. (2020). Robust estimation and inference of spatial panel data models with fixed effects. ***Japanese Journal of Statistics and Data Science* 3**, 257–311.
14. Yu, J., de Jong, R. and Lee, L. F. (2008). Quasi-maximum likelihood estimators for spatial dynamic panel data with fixed effects when both *n* and *T* are large. ***Journal of Econometrics* 146**, 118-134.
15. Yang, Z. L. (2018). Unified M-estimation of fixed-effects spatial dynamic panel data models with short panels. **Journal of Econometrics 205**, 423-447.
16. Yang, Z. L. (2021). Joint tests for dynamic and spatial effects in short dynamic panel data models with fixed effects and heteroskedasticity. ***Empirical Economics* 60**, 51-92.
17. Li, L. Y. and Yang, Z. L. (2020). Estimation of Fixed Effects Spatial Dynamic Panel Data Models with Small *T* and Unknown Heteroskedasticity. ***Regional Science and Urban Economics* 81**, 103520.

7. University Policies

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.

Copyright Notice

Please note that the course materials are meant for personal use only, namely, for the purposes of teaching, studying and research. You are strictly not permitted to make copies of or print additional copies or distribute such copies of the course materials or any parts thereof, for commercial gain or exchange. For the full copyright notice, please visit: https://smu.sg/Copyright-notice or OASIS > Campus Life & Exchange > Conduct & Discipline > University Council of Student Conduct.

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, with no disruption to the schedule. To familiarise students with the WebEx 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.

8. Weekly Lesson Plan

Week		Topic	Readings
1	15 Aug 22	**Introduction:** Common spatial econometric models; spatial weight matrices; quasi maximum likelihood (QML) estimation; M-estimation; generalized method of moments; Basics on matrix algebra.	Lecture1.pdf Papers 1 & 2
2	22 Aug 22	**Spatial linear regression models I:** QML estimation and inference; GMM estimation and inference; Empirical illustration.	Lecture2.pdf Papers 3 & 4 Matlab 1
3	29 Aug 22	**Spatial linear regression models II:** Tests of hypotheses: LM tests, standardized LM tests, empirical applications.	Lecture3.pdf Papers 5 & 6 Matlab 2
4	5 Sep 22	**Spatial linear regression models III:** Heteroskedasticity-robust estimation and inference; Empirical illustration.	Lecture4.pdf Paper 7 Matlab 3
5	12 Sep 22	**Spatial linear regression models IV*:**	Lecture5.pdf

		Bias-corrected estimation: general method; For SLR models with SL, SE and SLE; Refined inferences.	Papers 8 & 9 Matlab 4
6	19 Sep 22	**Spatial linear regression models V*:** LM tests for spatial dependence based on bootstrapped critical values; Empirical illustration.	Lecture6.pdf Paper 10 Matlab 5
7	26 Sep 22	**Spatial panel data models I:** Random effects model, Fixed effects model; QML estimation and inference; Empirical illustration.	Lecture7.pdf Papers 11 & 12 Matlab 6
8	3 Oct 22	Recess Week	
9	10 Oct 22	**Spatial panel data models II:** Hypothesis tests: LM tests, standardized LM tests; Empirical illustration.	Lecture8.pdf Papers 5 & 6 Matlab 7
10	17 Oct 22	**Spatial panel data models III:** Heteroskedasticity-robust estimation and inference for SPD models with fixed effects; Empirical illustration.	Lecture8.pdf Paper 13 Matlab 8
11	24 Oct 22	**Spatial dynamic panel data models I**: QMLE based on large panels; M-estimation and inference based on short panels; Empirical illustration.	Lecture8.pdf Papers 14 & 15 Lab 9
12	31 Oct 22	**Spatial dynamic panel data models II**: Tests for dynamic and spatial effects in SDPD models with fixed effects; Empirical illustrations.	Lecture11.pdf Papers 16 Lab 10
13	7 Nov 22	**Spatial dynamic panel data models III**: Heteroskedasticity-robust estimation and inference for SDPD models with fixed effects; Empirical illustration.	Lecture12.pdf Paper 17 Matlab 11
14	14 Nov 22	Revision Week	
15	21 Nov 22	Final Examination	
16	28 Nov 22		

***** These are more advanced topics, which will only be 'fully' introduced if time permits.