Simultaneous Equation Models (SiEM)

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Sandy Marquart-Pyatt
Department of Sociology & Environmental Science and Policy Program
Michigan State University
marqua41@msu.edu

This course considers systems of equations, drawing from two complementary approaches: the structural equation modeling with latent variables (SEM) literature and the econometrics literature (SiEM). In contrast to single equation models, these models have at least two equations. These simultaneous models can be grouped into two major types: recursive models, which do not create any special problems, and nonrecursive models, which require special treatment. For each of these major types, we will discuss the specification, identification, estimation, and assessment of these simultaneous equation systems. Nonrecursive models introduce the problem of identification, or how to establish that the parameters of the model are estimable. These models also require alternative estimation techniques.

As time permits, advanced topics will be covered. Students should have a good understanding of multiple regression and matrix algebra. We will be using SAS and STATA.

Required text:


Readings are also drawn from the following four econometric texts:


Additional readings are drawn from the following structural equation modeling (SEM) texts:


All required readings are available in the summer program library in the Newberry House.
There will be approximately 6 assignments. Due dates of assignments will be announced in class. We will also be discussing application papers as appropriate to non-recursive models (listed on last page of syllabus). Lab sessions will be announced in class.

**Topics and Readings:**

**I. Introduction to Simultaneous Equation Models**

a. A brief introduction to simultaneous equation models

**II: Review of the Classical Linear Regression model**

a. Review of matrix algebra

Readings:
- Fox, John. 2009. *A Mathematical Primer for Social Statistics.* SAGE Publications, Inc. QASS. Chapter 1, Section 1.1 pp. 2-18 and Section 1.4 pp. 30-40. OR
- Johnston and DiNardo: pp. 459-483

b. Classical linear regression model

Readings:
- Gujarati: ch.4 OR
- Greene: ch.2 (ch. 6) OR
- Johnston & Dinardo: ch.3 (ed 3: ch 5)

Note: for further review, read Gujarati ch.1-3 & 6, or Johnston & DiNardo chp.1-2, etc. first.

**III: Overview of simultaneous equation models**

Recursive vs. nonrecursive models; path diagrams/equations/matrices; reduced vs. structural form; direct, indirect and total effects.

Readings:
- Paxton, Hipp, & Marquart-Pyatt: Chps. 1 & 2
- Gujarati: chp.18
- Bollen: pp.32-34; 36-39
IV: Recursive models

a. Specification

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp 2 p. 4-17
Gujarati: p. 764
Kmenta: pp.719-720

b. Identification

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 3 p. 24-30
Bollen: p. 88-98
Kenny: p. 34-41, 61-62
Greene: 13.3

c. Estimation

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 4 p. 46-48
Gujarati: p. 681-682
Johnston: p. 468-469 (ed. 4: 314-318)
Kmenta: p. 720

d. Assessment

Decomposition of effects

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 6 (pp. 88-97)
Bollen: pp.36-39

Mediation in SiEM** (see extended list on z: drive).

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 6 (pp. 100-114)

Optional Reading:

V: SUR (seemingly unrelated regressions) models

Readings:
Greene: 10.2, 15.6.3
Kmenta: 12.3

Example:

VI: Nonrecursive simultaneous equation models

a. Specification
Reading:
Paxton, Hipp, & Marquart-Pyatt: Chp 2 (esp p. 17-23)
Gujarati: 18.3-18.4

b. Identification
Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 3
Gujarati: chp.19.1-19.3
Greene: 13.3.1-13.3.2

c. Estimation: ILS, 2SLS, 3SLS, ML
Reading:
Paxton, Hipp, & Marquart-Pyatt: Chp. 4
Gujarati: 20.1

c1. Indirect least squares
Readings:
c2. Two Stage Least Squares, aka 2SLS
Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 4 p. 48-53
Gujarati: 20.4, 20.5
Greene: 13.4, 13.5.2, and 13.5.3
Kmenta: pp.681-687

Examples:


c3. 3SLS
Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 4 p. 53-54
Johnston: pp.486-490
Kmenta: pp.695-701
Greene 13.6, 13.6.1

c4. MLE
Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 4 p. 55
Greene: 13.6.2

d. Comparison of Estimation Methods
Reading:
Paxton, Hipp, & Marquart-Pyatt: Chp. 4 pp. 51-53 & 56-58
Greene: 13.7
Kmenta: pp.711-714

e. Decomposition of Effects
Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 6
Bollen: pp.376-389
VII. Assessment of models

a. Equation by equation

a1. Assessment of Instruments

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 5 pp. 73-78
Optional reading** (see extended list on z: drive):

a2. Endogeneity tests:

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 5 pp. 78-80
Gujarati: 19.4-19.5
Greene: 13.8

b. Global goodness of fit statistics for overidentified models

Readings:
Paxton, Hipp, & Marquart-Pyatt: Chp. 5 (pages 67-73)
Bollen: pp.263-289
**Additional Topics: (including seminal cites and covered as time permits)**

**Modeling change**  
*Readings:*  

*Optional Reading:*  

**Consequences of measurement error**  
*Reading:*  
Bollen: chp.5; Greene: 9.5

**Simultaneous equations with limited dependent variables**  
*Readings:*  


*Optional readings:* Maddala 5.1, 5.8, chapter 7 and chapter 8.  
*Example:*  

**Standard Errors of indirect effects**  
*Readings:*  
Power Issues in Simultaneous Equations

Readings:

Lagged Endogenous Variables with autocorrelation

Readings:
Kmenta: 13.5

Using simultaneous equations to handle spatial effects

Readings:

Autocorrelation or heteroskedasticity in simultaneous equations

Readings:
Kmenta: 13.5

Application Papers with tentative presentation dates (subject to change):

SUR: Presentation & Discussion on Wednesday July 31.

Nonrecursive I: Presentation & Discussion on Thursday, Aug 8.

Nonrecursive II: Presentation & Discussion on Friday, Aug 9.

Nonrecursive III: Presentation & Discussion on Thursday, Aug 15.