

## CAUSAL ANALYSIS

### Doctoral School Faculty of Business and Economics Spring 2023

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Assistant Office hours:	By appointment
Class meets:	Monday 20 Feb (extra lesson): 1300-1700 in Extranef 110 All Tuesdays during term: 1300-1700 in Extranef 110 except March 14, 21, April 25 and May 30: 1300-1700 in Internef 201
Credits:	6 ECTS (outside students may audit the class with my approval)
Registration:	To register contact the Doctoral School Executive Assistant, Bénédicte Moreira ( <a href="mailto:Benedicte.Moreira@unil.ch">Benedicte.Moreira@unil.ch</a> )
Website:	Moodle (password will be e-mailed to registered students)

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### COURSE DESCRIPTION

The use of causal analysis methods, whether using advanced regression methods or maximum likelihood estimation have mushroomed in the past couple of decades. Today they are widely recognized as one of the most powerful and most comprehensive methods for testing causal hypotheses. Knowledge of causality is essential for informing policy and practice.

The purpose of this course is to familiarize the students with conceptual bases of causal analysis as well as applications necessary to undertake doctoral-level research and to answer questions of causal interest. Students will learn to critically think about causal relations, particularly in the design of studies, measurement of variables, and testing of theories. There will also be many demonstrations and hands-on exercises using Stata so that students have the necessary tools to analyze causal hypotheses correctly. Students will also learn basic programming commands in Stata as well as some fundamentals of Monte Carlo simulation. The software, Stata 17, is available on line via the university network: <https://www.unil.ch/ci/distrisoft>

Please come to class with your laptop and Stata 17 installed and up-to-date. (run “update” once installed)

### COURSE CONTENT

In this course, students will learn about:

1. Endogeneity and causality
2. Advanced regression topics, including interpreting and testing interaction models, errors-in-variables models, instrumental variable estimators, fixed- and random-effects models, and simultaneous equation models using least squares and maximum likelihood
3. Structural equation modeling including confirmatory factor analysis, latent variable models, higher-order models, multisample models, growth curve models, and model implied instrumental variables.
4. Monte Carlo analysis

The course is designed as a doctoral seminar, though a very structured one so as to maximize student learning. Students are **very strongly advised** to do assigned readings and homework, because they are essential in helping students understand the course material and being well prepared to successfully pass the project and final examination. Note, I am providing many readings from my own work, given its relevance for the course and because I can also answer detailed questions about it.

## ASSESSMENTS

1. 15%: homework exercises (submit homework exercises/Stata code by midday, 12h00, of the Tuesday following the relevant class to the course assistant by e-mail); Grades for homework that are submitted late will be reduced by 1 point for each day being late (rounded to the next day).
2. 5%: Critique of articles
3. 25%: Project: Monte Carlo experiment (submitted paper and final presentation)
4. 55%: Final exam (open book exam)—theory and practice

Resit: The mark for students who fail the course will be composed of the marks received in assessment (1) and the failed component, weighted as per the above; students must resit the assessment/s failed. In the event that a pass cannot be guaranteed by passing the failed component alone with a minimum of 4, the student must redo (2), (3) and (4).

## FORMATTING GUIDELINES

For the **project and article critiques**, please submit to the course assistant by e-mail using the following specifications: Double-spaced, using Times New Roman font (12 points) with default margins (2.5cm all around). Include a cover page (not counted in the page requirement) indicating your name and the type of assessment.

Important: For all work you do, please submit original work. For any project work you do or during the exam, please cite correctly and do not plagiarize; I have **failed** students in the past for plagiarism (and have a good nose for it), so please do not even let it cross your mind to use someone else's work without correct attribution. If you do not know how to cite correctly refer to a style guide like that of the APA (American Psychological Association). The same goes for homework. If you do not use your own original code you will be failed.

## PROJECT BRIEF FOR ARTICLE CRITIQUES

This project will consist of applying the concept acquired in the class to critiquing 3 articles across various management disciplines. You will be required to read the assigned articles and be prepared to discuss each of the articles. We will spend about 30-45 minutes on discussing each article and every student will partake in the discussion.

You are also required to write max. 2 pages of critique per article (which you must send to the course assistant by e-mail before 13h00 for each relevant session. For each relevant week (weeks 10 and 12), please (a) send everything in **one** file (and not separate files), (b) follow the formatting guidelines for the critique (see point in previous section), (c) clearly list (number) each of the pitfalls and each of the solutions, and (d) submit article critiques in the order in which I have listed them in the syllabus. For each paper critiqued you will be evaluated on three components:

1. Explain the basic model that was estimated by the authors (10% of mark)
2. Discuss critical errors that the authors made (40% of mark)
3. Explain how the model could be estimated to ensure correct identification of the causal effect (50% of mark).

Given the weightings the first and second component should be about a page and the last component a page also. The following article is essential background reading for the critiques:

Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, 21(6). 1086-1120.

Pull out a few of the papers that Antonakis et al. (2010) coded, read them, and see what critical errors we found. Note: There may be several problems and issues with each of the papers. Please focus on identifying the major ones. Do not spend time talking about very minor ones like:

- they did not use a robust variance estimator
- they did not check for heteroskedasticity
- they did not rely on the chi-square test of fit in the SEM
- they used CFI or RMSEA (or the like) to evaluate model fit
- they did not correct for measurement error
- (in the case of endogenous regressors) recommend that the researchers should have used “instruments” (say rather which instruments they should have used)
- they could have used a Monte Carlo (to do what? Explain in detail to get points)

Comments of the sort listed above, even if correct, will not give you any marks (so do not even bother making them). Look for issues that render estimates inconsistent; if the research is experimental, then think whether demand effects may drive results and whether there is an appropriate control group. In this respect see:

Lonati, S., Quiroga, B. F., Zehnder, C., & Antonakis, J. (2018). On doing relevant and rigorous experiments: Review and recommendations. *Journal of Operations Management*, 64, 19-40.

If you give several substantive (i.e., about 5-6) examples of problems and tangible ways to deal with them you will receive full marks for the paper critique. We will give you progressively fewer marks as the substantive content of the critique is reduced. Note, too, that describing the paper is only 20% of the mark, and the rest is on the critical errors and solutions; so please do not spend too much space on describing the basic model that was estimated. Please ensure you put the meat where the meat is needed. To get an idea of what “substantive” means, read the following paper, which on first reading may look like a very strong paper, particularly because it was published in a top journal:

Christian, M. S., & Ellis, A. P. J. (2011). Examining the effects of sleep deprivation on workplace deviance: A self-regulatory perspective. *Academy of Management Journal*, 54(5), 913-934.

However, all papers can be improved upon. Here are some important issues with the paper that one could have critiqued (the points below are summarized; more extended details would be required from you):

### Study 1

1. The sample self-selected, particularly to work shift; thus, there is a potential grouping variable (which is endogenous) and which is not controlled for using some sort of IV procedure.
2. The data are all self-reported data, which creates a problem of common methods variance (in addition to the untrustworthy data on the dependent variable). It would have been better to split the data-gathering and having bosses or peers report on the DVs.
3. Reverse causality is possible in the sense that those who are irritable and aggressive may sleep less; the way to deal with this is to randomize to sleep deprivation condition or to find instruments (e.g., age, personality might predict sleep).
4. The estimator is not an IV-estimator; it was estimated with OLS (and to the extent that the mediator is endogenous, failure to use an IV estimator will engender inconsistent estimates). Thus, they should have used 2SLS or ML (with disturbances of the mediator and outcome correlated).

### Study 2

5. There is a confound in the manipulation (i.e., sleep deprivation with putting people in a group all night long—being in a group, when in a difficult situation, could have made individuals grumpy)—this confound induces endogeneity. Thus, the control group should have had this manipulation too (or the experimental group should not have had it).
6. The regressors are endogenous; thus, their effects on outcome must be tested with an IV estimator (as per (4) above).
7. Related to the above, the problem with testing the whole model with an IV estimator is that it is impossible to do so because the system of equations is under-identified (i.e.,  $DF = -1$ ); the model is thus not causally identified. Thus, they should have included more exogenous variables as instruments or manipulated a second variable (crossing it with sleep deprivation).
8. There are omitted control variables (e.g., sex, age, etc.) that are not included in the regression model. The controls are essential because of the small sample size it is possible that randomization to treatment (across sex, age, personality, what have you) is not perfect.

So, the above are examples of “meaty” comments. Thus, please ensure to make tangible and context-specific recommendations that are of substance.

## PROJECT BRIEF FOR MONTE CARLO EXPERIMENT

The project consists of undertaking a Monte Carlo analysis to answer a specific question about an apparently widely accepted rule of thumb or particular practice; the level of difficulty and what you discover—something surprising or counterintuitive—will determine your maximum grade, as well how much help you have sought from me or the course assistant. Essentially try to find a situation where a widely used practice may be questionable because it is not derived from a proof; or if the small sample properties of a proven estimator are not clear. Discovering something new and interesting may even be useful in a publication! If you just chose to do something very simple, or of the course assistant helps you a lot in developing your code, the maximum grade you can receive is reduced.

Here are some examples, to help you get ideas:

- The chi-square test of fit is too powerful to assess overidentification, particularly at large sample sizes (Hu & Bentler, 1999)
- Approximate fit indices indicating  $RMSEA < .06$ ,  $CFI > .95$ , or  $SRMR < .08$  indicate a good fitting model that can be causally interpreted (Hu & Bentler, 1999)
- Factor loadings should be at least .30 for interpretable results (many references for this, but see Olatunji et al., 2007 as an example)
- Independent variables should not correlate more than .70 or .80 with each other to avoid issues related to collinearity and singularity (many textbook sources for this)
- VIFs should be less than 10 to ensure stable results (this is a widely reported rule of thumb).
- Control variables that do not correlate significantly with  $y$  should be excluded from the predictive model (cf. Becker, 2005)
- Interactions are not that much affected by common-method variance (cf. Evans, 1985)
- Common-method variance (with respect to  $x$  and  $y$ ) can be eliminated by including a latent common-method factor (Loehlin, 1992).
- At least 20 observations are required for each parameter estimated in SEM models (Kline, 2010)
- A model with 10 parameters should have a sample of at least 100 (Kline, 2010)
- At least 10 observations are required for each variable in a regression model (several sources on this)
- AIC and BIC are useful adjudicators of model fit
- Etc.

Note, if you are going to choose one of the examples above, please send an e-mail ASAP to the course assistant. Only one student can work on a particular topic (unless what is studied is substantially different by the two students); thus, we will operate on a first come first serve basis. You will need explicit approval from my assistant, in writing, to confirm the topic you have chosen is OK (and we will give you formal feedback on the direction you are taking with your project as indicated in the course schedule).

The goal of the project is thus to identify some rule of thumb or suggested practice about regression or SEM, reported in a textbook, methods piece, or applied piece, and then to either debunk or to find support for it (at the least you must show something new; if you will find support for the practice or rule of thumb then do so with manipulating a dimension that has not been manipulated previously). Keep the model as simple as possible and vary sample size

across a few increments and then manipulate at least two other parameters (or more) of interest. I will, of course, give you a few examples of how to do this. Note, trends may not be obvious to the naked eye; thus, you must conduct tests on the trends as a function of the manipulations (e.g., use trends as a DV and the manipulations as an IV to see what affects the DV). See the following paper for more information on how to do this—I will also show you examples in class:

Bastardoz, N., & Antonakis, J. (2016). How should the fit of structural equation models be judged? Insights from Monte Carlo simulations. *Academy of Management Proceedings*, 12634.

The project (*and the presentation slides that you will use to present it*) must be submitted to the course assistant by e-mail before 12h00 on **Monday 29-5-2023**. We will mark your project on the following:

1. 10%: Introduction to the rule of thumb; literature review showing a few examples of the rule of thumb (1 page max).
2. 5%: Discussion of why the rule of thumb may not or may be necessary valid for particular contexts (1 page max).
3. 25%: Explaining the set-up of the Monte Carlo and choice of manipulations
4. 15%: Presentation of the results of the Monte Carlo simulation (visual/graphic)
5. 20%: Discussion and interpretation of the results of the Monte Carlo simulation
6. 5%: Writing style, logic, general presentation
7. 20%: In-class oral presentation and answering of questions

The project should be between 8-10 pages long (excluding the cover page and excluding the Appendix); please give a title to the project (e.g., “Can RSMEA be trusted to detect misspecified models?”—giving the title in question format is a good idea because it provides focus). Please include the full code you used for the Monte Carlo as an Appendix in the project (not counted in the page length) and not as a separate attachment. The project should be submitted in **ONE** file.

You will present the project in class as per a randomly determined schedule. I will confirm a few weeks before how long the presentation will be (it depends on how many students will take the class). Usually it is a presentation on your part of about 20 minutes + 10 minutes of questions from me and Tyler.

### **Note about the project:**

There is one simple recipe to succeed on this project—carefully follow the examples in class from the first lesson, re-run the code to understand it, do all the homework, and check your homework against the code we give you. If you do not understand something, ask me or the course assistant. The class gradually builds up, so ensure that you really understand everything from the first lesson. *Do not fall behind! Falling behind = high probability of failure!*

Learning basic programming skills now will help greatly for your Monte Carlo; more importantly it will help you in the long term too. Once you know how to do a Monte Carlo, this will help you in publishing empirical papers and in particular to handle reviewer comments (I will show you examples of this in class where Monte Carlo analysis helped me to publish papers that were not about Monte Carlo per se).

Finally, I or the course assistant will not debug your code for you; the sooner you come to us for help with specific questions about your code the more we can and will help you. But please do not send us a bunch of code, screaming in desperation “my code doesn’t work!” You need to do the debugging yourself because this part of the learning experience. And, finally, please do not leave the programming for the last minute; that would be a guaranteed recipe for failure. Here are some example projects to give you an idea of what has been done previously:

- Should factor loadings should be at least .30 for interpretable results?
- What is the minimum required sample size in regression models? Relative bias of two-stage least square (2SLS) and ordinary least square (OLS) estimations
- Approximate fit index RMSEA: A Monte Carlo experiment on a rule of thumb
- When the cure is worse than the disease: A Monte-Carlo experiment to test if “Common-method variance (with respect to x and y) can be eliminated by including a latent common-method factor”
- Should control variables only be included in a model under the condition that they correlate with the dependent variable?
- Is the chi-square test of fit is too powerful to assess overidentification, particularly at large sample sizes?
- Ratio of sample size to parameters for regression models
- Should independent variables not correlate more than .70 or .80 with each other to avoid issues related to collinearity and singularity?
- Impact of common-method bias on the interaction term – modelled as an omitted variable issue
- Are at least 20 observations required for each parameter estimated in SEM models?
- Should groups’ ratio in a sample not exceed 1:2 allocation to avoid a loss of power.
- Should control variables that do not correlate significantly with y be excluded from the predictive model?
- Common-Method Variance – A test of a potentially more accurate post-hoc technique
- Does a Cronbach alpha superior (or equal) to 0.7 really absolve you from modelling measurement error?
- Can a weak instrument be detected with an F-statistic smaller than 10?
- Should control variables that do not correlate significantly with the dependent variable be excluded from the predictive model?
- Effect of sample size, degree of endogeneity, and number of indicators on the estimated coefficients in SEM
- Should VIFs be less than 10?
- Factor loadings: investigating the rules of thumb
- Is it ever justified to use a Dawes-model for predictions?
- Weak instruments: Is more better?
- Detecting Weak Instruments: Avoiding a cure worse than the disease
- Fast and Frugal Regression: Take-The-Best competing with multiple regression
- When do control variables matter?
- What constitutes a sufficient sample size for estimation in multilevel modeling?
- Endogeneity tests: Which one to trust?
- Can model implied instruments reliably estimate latent interactions and latent quadratic terms?
- The marker variable technique: A relevant statistical technique to control for CMV?

## COURSE SCHEDULE

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### Monday 20-2-2023 (optional lesson)

**Note:** You should come to this class if you have never used Stata and particularly if you have not had any courses previously in econometrics. Students who have studied here for their BSc and MSc and have taken many econometrics classes, and who have started the Ph.D. program in autumn (and took the course on Experiments and Quasi-experiments) can opt out of this lesson, but of course are welcome to if they wish.

**Topic:** Introduction to testing causal hypotheses; experimental research; introduction to endogeneity; introduction to SEM and regression. Basic notations for regression and path diagrams; introduction to Stata.

**Required reading:** 1. Jacquart, P., Cole, M. S., Gabriel, A. S., Koopman, J., & Rosen, C. C. 2017. Studying leadership: Research design and methods. In J. Antonakis & D. V. Day (Eds.), *The Nature of Leadership*, 3 ed.: 411-437. Thousand Oaks: Sage. (this chapter is written in a general way and understandable to individuals from various disciplines).

**Lab topics:** Familiarization with Stata; basic data manipulation; estimating basic models.

Review the following commands by typing “help [command]”; then run the commands using the systems data set that is noted in the help file. Note, many of the commands can be abbreviated; and many of the commands can be used with the menus. We will use the following commands:

*Basic operations with respect files:* clear, use, edit, sysuse, save, preserve, restore

*Basic operations with respect to variables:* describe, list, summarize, codebook, generate, label, replace, egen, keep, drop, recode, tabulate, tabulate (for generating dummy variables, i.e., “tab country, gen(d)”)

*Basic operations to manage data:* sort, gsort, order, reshape, merge

*Basic operations with respect to estimation:* pwcorr, corr, ttest, anova, regress, logit, probit

*Keeping track of your work:* do files, log files.

*Installing user-written commands:* ssc install, findit



Week 1; Tuesday 21-2-2023

- Topic: Introduction to the course. The problem of endogeneity:
1. Basic omitted variable bias
  2. Errors-in-variables (using least squares and SEM)
  3. Common-method variance
- Required reading:
1. Jacquart, P., Cole, M. S., Gabriel, A. S., Koopman, J., & Rosen, C. C. 2017. Studying leadership: Research design and methods. In J. Antonakis & D. V. Day (Eds.), *The Nature of Leadership*, 3 ed.: 411-437. Thousand Oaks: Sage. (this chapter is written in a general way and understandable to individuals from various disciplines).
  2. Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2014). Causality and endogeneity: Problems and solutions. In D.V. Day (Ed.), *The Oxford Handbook of Leadership and Organizations*. Read pages 1-29 only.
  3. Schwarz, N. 1999. Self-reports - How the questions shape the answers. *American Psychologist*, 54(2): 93-105.
- Recommended :
1. Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, 21(6). 1086-1120. Read pages 1086-1092 (up to section 3.1.1); Section 3.3, 3.4, 8
  2. Lonati, S., Quiroga, B. F., Zehnder, C., & Antonakis, J. (2018). On doing relevant and rigorous experiments: Review and recommendations. *Journal of Operations Management*, 64, 19-40. (scan pp. 19-28 (till end of section 3))
- Lab topics:
- Generating data with known structures (generate a data set in which  $x$  is endogenous). Generating data with loops. We will use the following commands or command options (-[option]-):
- set obs, set seed, gen, -rnormal()-, foreach, regress, alpha, eivreg, sem, est store, est tab, esttab, outreg2, putdocx

Week 2; Tuesday 28-2-2023

- Topic: Regression models in Stata
1. Multiple IVs and dummy variables (and coefficients); relation to ANOVA
  2. Nested model F-test and hypothesis tests (Wald tests)
  3. Marginal effects
  4. Interactions (estimating and plotting)
  5. Testing congruence (brief introduction)—see notes on Moodle
  6. Regression diagnostics

Required reading:

(Practical example) 1. Dawson, J. F. (2014). Moderation in management research: What, why, when, and how. *Journal of Business and Psychology*, 29(1), 1-19.

Suggested readings for congruence testing (for those interested):

(Practical example) 1. Lee, Y. T., & Antonakis, J. (2014). When Preference Is Not Satisfied but the Individual Is: How Power Distance Affects Person-Job Fit. *Journal of Management*, 40(3), 641-675. (Scan this to see what can easily be done with Stata with respect to testing pretty much anything; see supplementary notes on the Moodle for more information if you need to test response surfaces).

2. Shanock, L. R., Baran, B. E., Gentry, W. A., Pattison, S. C., & Heggestad, E. D. (2010). Polynomial Regression with Response Surface Analysis: A Powerful Approach for Examining Moderation and Overcoming Limitations of Difference Scores. *Journal of Business and Psychology*, 25(4), 543-554.

Lab topics: Estimating regression models in practice. We will use the following commands or command options (-[option]-):

oneway, anova, regress, hausman, suest, lincom, test, bootstrap, margins, -robust-,

### Week 3; Tuesday 7-3-2023

Topic: Two-stage equation models in Stata;

1. Two-stage least squares (instrumental variable) estimator
2. Tests for overidentifying restrictions; what the chi-square test means
3. Hausman test for endogeneity and augmented regression tests (Durbin–Wu–Hausman)
4. Tests of mediation (Sobel-Goodman Tests)
5. Bootstrapping

Required reading: 1. Bastardo, N., Matthews, M., Sajons, G., Ransom, T., Kelemen, T. K., & Matthews, S. H. 2023. Instrumental Variables Estimation: Assumptions, Pitfalls, and Guidelines. *The Leadership Quarterly*. <https://doi.org/10.1016/j.leaqua.2022.101673>

2. Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, 21(6). 1086-1120. Read 4.2.1, 4.2.1.4 (Example 1 only)

Suggested reading: For experimentalists you must absolutely look at this paper:

1. Sajons, G. B. (2020). Estimating the causal effect of measured endogenous variables: A tutorial on experimentally randomized instrumental variables. *The Leadership Quarterly*, 31(5), 101348.

Else, refer to one or two of the following, which is closest to your field:

1. Bascle, G. (2008). Controlling for endogeneity with instrumental variables in strategic management research. *Strategic Organization*, 6(3), 285-327.
2. Bettis, R., Gambardella, A., Helfat, C., & Mitchell, W. (2014). Editorial: Quantitative empirical analysis in strategic management. *Strategic Management Journal*, 35(7), 949-953.
3. Duncan, G. J., Magnusson, K. A., & Ludwig, J. (2004). The Endogeneity Problem in Developmental Studies. *Research in Human Development*, 1(1&2), 59-80.
4. Gennetian, L. A., Magnuson, K., & Morris, P. A. (2008). From statistical associations to causation: What developmentalists can learn from instrumental variables techniques coupled with experimental data. *Developmental Psychology*, 44(2), 381-394.
5. Hamilton, B. H., & Nickerson, J. A. (2003). Correcting for endogeneity in strategic management research. *Strategic Organization*, 1(1), 51-78.
6. Hill, A. D., Johnson, S. G., Greco, L. M., O'Boyle, E. H., & Walter, S. L. (2021). Endogeneity: A review and agenda for the methodology-practice divide affecting micro and macro research. *Journal of Management*, 47(1), 105-143.
7. Ketokivi, M., & McIntosh, C. N. (2017). Addressing the endogeneity dilemma in operations management research: Theoretical, empirical, and pragmatic considerations. *Journal of Operations Management*, 52, 1-14.
8. Larcker, D. F., & Rusticus, T. O. (2010). On the use of instrumental variables in accounting research. *Journal of Accounting and Economics*, 49(3), 186-205.
9. Maula, M., & Stam, W. (2020). Enhancing rigor in quantitative entrepreneurship research. *Entrepreneurship Theory and Practice*, 44(6), 1059-1090.
10. Maydeu-Olivares, A., Shi, D., & Fairchild, A. J. (2020). Estimating causal effects in linear regression models with observational data: The instrumental variables regression model. *Psychological Methods*, 25(2), 243-258.
11. Reeb, D., Sakakibara, M., & Mahmood, I. P. (2012). From the Editors: Endogeneity in international business research. *Journal of International Business Studies*, 43(3), 211-218.
12. Shaver, J. M. (2020). Causal identification through a cumulative body of research in the study of strategy and organizations. *Journal of Management*, 46(7), 1244-1256.
13. Ullah, S., Zaefarian, G., & Ullah, F. (2021). How to use instrumental variables in addressing endogeneity? A step-by-step procedure for non-specialists. *Industrial Marketing Management*, 96, A1-A6.

Lab topics:

We will estimate models using the following commands: `ivregress`, `ivreg2`, `reg3`, `sem`, `sgmediation`, `test`, `nlcom`, `hausman`, `bootstrap`

Week 4; Tuesday 14-3-2023

- Topic:
1. Simultaneous equation models and seemingly unrelated models
    - a. Multiple dependent variables
    - b. Seemingly-unrelated regression/estimation
    - c. Path models with three-stage least squares
    - d. Path models with sem
    - e. Simultaneity
    - f. Cross-equation Wald tests and Chow tests
  2. Path and SEM models:
    - a. ML estimation and assumptions
    - b. SEM discrepancy function
    - c. Calculating the chi-square manually for path (IV) models
    - d. Likelihood ratio tests (for nested models)

- Required reading:
1. Bollen, K. A. (1998). Structural equation models. John Wiley & Sons, Ltd. Read Chapter 2, pp. 10-39.
  2. MacCallum, R. C., & Austin, J. T. (2000). Applications of Structural Equation Modeling in Psychological Research. Annual Review of Psychology, 51(1), 201-226.

Lab topics: We will estimate model using the following commands: sureg, cmp, reg3, sem, suest, test

Week 5; Tuesday 21-3-2023

- Topics: Confirmatory factor analysis and advanced topics
1. CFA models, basic and multifactor; calculating chi-square
  2. Evaluating fit: fit statistics, residuals, modification indices (Lagrange tests)
  3. SEM model with latent variables
  4. SEM Mediation models
  5. Likelihood ratio tests and Wald tests for parameter constraints
  6. Higher-order factor models

- Required reading:
1. Tomarken, A. J., & Waller, N. G. (2005). Structural Equation Modeling: Strengths, Limitations, and Misconceptions. Annual Review of Clinical Psychology, 1(1), 31-65.

- Further reading:  
(optional)
1. Credé, M., & Harms, P. D. (2015). 25 years of higher-order confirmatory factor analysis in the organizational sciences: A critical review and development of reporting recommendations. Journal of Organizational Behavior, 36(6), 845-872.

Lab topics: We will estimate model using the following commands: sem (and various sem options). We will also use some of the basic matrix commands of Stata (determinants, trace, inverse)

Week 6; Tuesday 28-3-2023

Topic: Advanced path and SEM models in Stata with latent variables I

1. A note on fit and a bit more on Monte Carlo
2. On local and global fit
3. Model implied instrumental variables with ML and 2sls
4. Latent variable interaction models

Required reading : 1. Ropovik, I. 2015. A cautionary note on testing latent variable models. *Frontiers in Psychology*, 6(1715).

Suggested reading: 1. Bollen, K. A. 2012. Instrumental Variables in Sociology and the Social Sciences. *Annual Review of Sociology*, 38(1): 37-72.

Lab topics: We will estimate model using the following commands: sem (and various sem options), ssd.

Week 7; Tuesday 4-4-2023

Topic: Advanced path and SEM models in Stata with latent variables II

1. Multisample (multiple group) models (same and different DVs) and tests of invariance
2. MIMIC models
3. Seemingly unrelated SE models (same and different DVs)
4. Analyzing secondary data (using covariance) matrixes (with ssd and corr2data)

Required reading: 1. An example of analyzing secondary data: Antonakis, J. (2009). “Emotional intelligence”: What does it measure and does it matter for leadership? In G. B. Graen (Ed.), *LMX leadership--Game-Changing Designs: Research-Based Tools* (Vol. VII, pp. 163-192). Greenwich, CT: Information Age Publishing.

Suggested reading: 1. An example of MIMIC models (studies 1 and 2): Antonakis, J., & House, R. J. 2014. Instrumental leadership: Measurement and extension of transformational–transactional leadership theory. *The Leadership Quarterly*, 25: 746-771.

Week 8; Tuesday 18-4-2023

Topic: Panel data, SEM style

1. Fixed-effects models
2. Random-effects model
3. Combining fixed- and random-effects (the “Mundlak” CRE estimator)
4. Growth curve models

Required reading: 1. Antonakis, J., Bastardo, N., & Rönkkö, M. (2021). On Ignoring the Random Effects Assumption in Multilevel Models: Review, Critique, and Recommendations. *Organizational Research Methods*, 24(2), 443-483. (read 443-456; 461-468)

2. Bollen, K. A., & Brand, J. E. (2010). A General Panel Model with Random and Fixed Effects: A Structural Equations Approach. *Social Forces*, 89(1), 1-34.

Suggested reading: 1. McNeish, D., & Kelley, K. (2018). Fixed effects models versus mixed effects models for clustered data: Reviewing the approaches, disentangling the differences, and making recommendations. *Psychological Methods*, 24(1), 20-35.

2. Bliese, P. D., Schepker, D. J., Essman, S. M., & Ployhart, R. E. (2020). Bridging Methodological Divides Between Macro- and Microresearch: Endogeneity and Methods for Panel Data. *Journal of Management*, 46(1), 70-99.

Practical example: 1. Growth curve model (see Study 2): Bendahan, S., Zehnder, C., Pralong, F. P., & Antonakis, J. 2015. Leader corruption depends on power and testosterone. *The Leadership Quarterly*, 26, 101-122.

Lab topics: We will estimate models with Stata using xtreg, and regress and also use the commands lincom and margins -cluster(id)-, \_n, expand, and sem

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Week 9; Tuesday 25-4-2023

Topic: Monte Carlo simulations.

Required reading: 1. Paxton, P., Curran, P. J., Bollen, K. A., Kirby, J., & Chen, F. N. (2001). Monte Carlo Experiments: Design and Implementation. *Structural Equation Modeling-a Multidisciplinary Journal*, 8(2), 287-312.

2. Muthen, L. K., & Muthen, B. O. (2002). How to use a Monte Carlo study to decide on sample size and determine power. *Structural Equation Modeling*, 9(4), 599-620.

Practical example: 1. Bastardo, N. & Antonakis, J. 2016. How should the fit of structural equation models be judged? Insights from Monte Carlo simulations. *Academy of Management Proceedings*, 12634.

Optional reading: (for examples) 1. Mewhort, D. J. K. (2005). A comparison of the randomization test with the F test when error is skewed. *Behavior Research Methods*, 37(3), 426-435.

2. Semadeni, M., Withers, M. C., & Certo, S. T. 2014. The perils of endogeneity and instrumental variables in strategy research: Understanding through simulations. *Strategic Management Journal*, 35(7): 1070-1079.

3. Antonakis, J., Bastardo, N., & Rönkkö, M. (2021). On Ignoring the Random Effects Assumption in Multilevel Models: Review, Critique,

and Recommendations. *Organizational Research Methods*, 24(2), 443-483. (read 456-461; the part on the simulation)

Lab topics: We will review code to generating data structures, including drawnorm, and basic code to write programs

Week 10; Tuesday 2-5-2023

Topic 1: You need to prepare a very brief overview of your Monte Carlo experiment. Please e-mail it to both John and Tyler before the start of the lesson; you are required to have only 4-5 slides on the Monte Carlo, which you will present in front of the class. On the first and second slide discuss the rule of thumb and whether you think it is baseless or a sound advice; on the third slide, discuss which variables you will manipulate for the Monte Carlo and why, and the basic setup of the Monte Carlo. On the fourth slide, present the basic code to show what you will manipulate (i.e., this code is to show only the data generation—highlighting the parameters you will manipulate)

Topic 2: Critique of one article

Article to critique: 1. Neerdaels, J., Tröster, C., & Van Quaquebeke, N. 2022. It's (a) Shame: Why Poverty Leads to Support for Authoritarianism. *Personality and Social Psychology Bulletin*.  
<https://doi.org/10.1177/01461672221141509>

Reading: In addition to all previous references, the following may help you to see problems more clearly for this lesson and that of Week 11: Wulff, J. N., Sajons, G. B., Pogrebna, G., Lonati, S., Bastardo, N., Banks, G. C., & Antonakis, J. 2023. Common Methodological Mistakes. *The Leadership Quarterly*. <https://doi.org/10.1016/j.leaqua.2023.101677>

Week 11; Tuesday 9-5-2023

I will meet with each of you, privately, during the week at a mutually convenient time to discuss the Monte Carlo project. We will set up a meeting schedule with you on Doodle, which we will communicate to you a couple of weeks before the meeting. If we need more time in which to meet all students meetings may go beyond the allotted class time (i.e., day before or full day of class).

Week 12; Tuesday 16-5-2023

Topic: Critique of 2 articles\*

Articles to critique: 1. Sergent, K., & Stajkovic, A. D. 2020. Women's leadership is associated with fewer deaths during the COVID-19 crisis: Quantitative and qualitative analyses of United States governors. *Journal of Applied Psychology*, 105(8): 771.

2. Biswas, D., Hartmann, P., Eisend, M., Szocs, C., Jochims, B., Apaolaza, V., Hermann, E., López, C. M., & Borges, A. 2022. Caffeine's Effects on Consumer Spending. *Journal of Marketing*.

\*this lesson will be between 2-3 hours long, depending on amount of discussion we have. I will be available for final (pointed) questions regarding your Monte Carlo presentations if required. Else you can use the time to work on your Monte Carlos.

Week 13: Tuesday 23-5-2023

Work on your Monte Carlos; the course assistant and the instructors will be available to answer questions.

Week 14: Tuesday 30-5-2023

Monte Carlo project presentations. Note, this session may start early and run late, depending on how many students are required to present. If we do not have sufficient slots in which to accommodate all students on this day, we may use Monday afternoon too. Thus do pre-emptively block all these times.

Final exam: Tuesday 13-6-2023

Final exam. Taken on the computer. You may use internet to search for information if you wish; however, no communication apps of any sort may be used and you may not communicate with anyone during the exam via any mode.



### References:

- Becker, T. E. (2005). Potential Problems in the Statistical Control of Variables in Organizational Research: A Qualitative Analysis With Recommendations. *Organizational Research Methods*, 8(3), 274-289.
- Evans, M. G. (1985). A Monte Carlo study of the effects of correlated method variance in moderated multiple regression analysis. *Organizational Behavior and Human Decision Processes*, 36, 305-323.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(1), 1-55.
- Kline, R. B. (2010). *Principles and practice of structural equation modeling* (4th ed.). New York: Guilford Press.
- Loehlin, J. C. (1992). *Latent variable models: An introduction to factor, path, and structural analysis* (2nd ed.). Hillsdale, N.J.: Lawrence Erlbaum Associates.
- Olatunji, B. O., Williams, N. L., Tolin, D. F., Abramowitz, J. S., Sawchuk, C. N., Lohr, J. M., et al. (2007). The disgust scale: Item analysis, factor structure, and suggestions for refinement. *Psychological Assessment*, 19(3), 281-297.

### **SUGGESTED REFERENCE BOOKS FOR YOUR PERSONAL LIBRARIES (PLEASE SERIOUSLY CONSIDER BUYING SOME OF THESE BOOKS)**

#### Stata and regression-related books:

Acock, A. C. (2016). *A gentle introduction to Stata* (5<sup>th</sup> edition). College Station, TX: Stata Press--gives a nice overview to Stata for those who have never used it (for basic use).

Baum, C. F. (2006). *An introduction to modern econometrics using Stata*. College Station, TX.: Stata Press.--a very useful general purpose reference guide for using Stata (for intermediatry-advanced use)

Cameron, A. C., & Trivedi, P. K. (2009). *Microeconometrics Using Stata*. College Station, TX: Stata Press. --an extremely useful general purpose reference guide for using Stata (for advanced use)

Long, J. S., & Freese, J. (2006). *Regression models for categorical dependent variables using Stata* (2nd ed.). College Station, TX: StataCorp LP. --an extremely useful reference guide for categorical dependent variables using Stata (for advanced use)

#### SEM and Mplus-related books:

Byrne, B. M. (2012). *Structural equation modelling with Mplus*. New York: Routledge.

Muthén, L. K., & Muthén, B. O. (2010). *Mplus user's guide* (6th ed.). Los Angeles, CA: Muthén & Muthén. <http://www.statmodel.com/ug excerpts.shtml>

Muthén, B., Muthén, L. K., & Asparouhov, T. 2016. *Regression and mediation analysis using Mplus*: Los Angeles, CA: Muthén & Muthén.

### General books on SEM

Bollen, K. A. (1989). Structural equations with latent variables. New York: John Wiley & Sons.--this book is **essential**, a classic, and will give you lots of information regarding SEM in general. It is quite advanced, so refer to this only for more detailed information on SEM issues. And, do not be fooled by the fact that it is dated; the book is timeless.

Brown, T. A. (2006). Confirmatory factor analysis for applied research. New York: Guilford Press.--basic introduction and reference guide.

Duncan, T. E., Duncan, S. C., Stryker, L. A., Li, F., & Alpert, A. (1999). An introduction to latent variable growth curve modeling: Concepts, issues, and applications. Mahwah, NJ: Lawrence Erlbaum Associates.--as denoted in the title, this book is essential reading for growth-curve models.

Heck, R.H., & Thomas, S.L. (2000). An introduction of multilevel modeling techniques. Mahwah, NJ: Lawrence Erlbaum Associates. --as denoted in the title, this book is essential reading for multilevel models.

Kline, R. B. 2015. Principles and practice of structural equation modeling (4th ed.). New York: Guilford Press.

Loehlin, J. C. (1992). Latent variable models: An introduction to factor, path, and structural analysis. Hillsdale, NJ: Lawrence Erlbaum.--basic introduction and reference guide.

Maruyama, G. M. (1998). Basics of structural equation modeling. Thousand Oaks, CA: Sage Publications.--basic introduction and reference guide.

The following are useful:

<https://stats.oarc.ucla.edu/other/dae/>

<https://stats.oarc.ucla.edu/stata/webbooks/reg/>

<http://www.stata.com/support/faqs/>

Stata-related books can be obtained on-line from [www.stata.com](http://www.stata.com) or locally from <http://www.scientific-solutions.ch/>

Note: for those of you who need to brush up on regression, see:

Angrist, J. D. & Pischke, J.-S. 2008. Mostly harmless econometrics: An empiricist's companion. Princeton: Princeton University Press.

Angrist, J. D. & Pischke, J.-S. 2014. Mastering 'metrics: The path from cause to effect. Princeton: Princeton University Press.

Stock, J. H., & Watson, M. W. (2007). Introduction to econometrics (2nd ed.). Boston: Pearson Addison Wesley.

Wooldridge, J. M. 2013. Introductory econometrics: A modern approach (5th ed.). Mason, OH: South-Western Cengage Learning.

Note: for those of you who need to brush up on experimental design, see:

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). Experimental and quasi-experimental designs for generalized causal inference. Boston: Houghton Mifflin.

And here is a very useful Youtube channel by my friend Mikko Rönkkö (really great resources):

<https://www.youtube.com/user/mronkko/videos>