Aalto University
School of Science

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

Advanced Statistical Research Methods
TU-L0040/JSBJ1311
Fall 2021-Spring 2022
7-10 Credits

Note: All course lectures are openly accessible on the course website and the units are available as playlists at https://www.youtube.com/mronkko

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1 COURSE STAFF AND CONTACT INFORMATION

Dr. Mikko Rönkkö Course instructor mikko.ronkko@aalto.fi
mikko.ronkko@jyu.fi

- All course assignments are available and returned through Aalto MyCourses.
- All articles and other reading materials are available through Zotero and/or the library.
- MyCourses forums are the primary communications channel of the course.
- Zoom and WhatsApp/Signal are used for instructing computer assignments
- Email the course instructor only in personal matters (e.g. if you miss a seminar.)

2 OVERVIEW OF THE COURSE

This is a blended learning course that contains both online and in-person elements. The course is organized by Aalto University and University of Jyväskylä and participants can obtain credits from either of these universities with a course code of their choice (TU-L0040/JSBJ1311).

This is an advanced level course that is designed to be completed after TU-L0022/JSBJ1310 Statistical Research Methods. Ideally, participants should already some experience in using quantitative research designs and data analysis techniques in their own research.

The goal of the course is to develop a more thorough understanding of how and why certain techniques are used and what principles these techniques are based on. The course focuses on longitudinal and multilevel designs and analyses. The techniques covered include all advanced econometrics and latent variable techniques used in *Academy of Management Journal, Journal of Applied Psychology, Journal of Management, Journal of Operations Management, Journal of Organizational Behavior, The Leadership Quarterly, Organization Science, Personnel Psychology,* and *Strategic Management Journal* as reported in a recent review[1]. The focus of the course will be on how these techniques can be used to empirically support causal claims taking particularly the issues of endogeneity and measurement validity into account. Compared to the basic Statistical Research Methods course, this course will focus much more on data analysis.

The course consists of ten units, that each take three to four weeks and contain video lectures, online and in-person discussions, and assignments. The number of credits varies between 7-10 depending on which assignments students choose to complete. The content of each course component is explained later in the syllabus. All data analysis assignments can be completed with Stata or R. Mplus can be used for some of the assignment or their parts.

Credits	Content
7	• Pre-exam • Video lectures and online participation • Readings and written assignments 1 and 2 • Data-analysis assignment for units 1-8 • Monte Carlo study • Paper presentation • Final exam
+0.5 each	Written assignments 3-8

Max 10 credits. The number of credits is rounded down.

[1] John Antonakis, Nicolas Bastardoz, and Mikko Rönkkö, "On Ignoring the Random-Effects Assumption in Multilevel Models: Review, Critique, and Recommendations," *Organizational Research Methods* forthcoming (2019), https://doi.org/10.1177/1094428119877457.

3 PARTICIPATION AND SIGNING UP

This course is targeted to students who have completed TU-L0022/JSBJ1310 Statistical Research Methods and want to deepen their understanding of quantitative research methods. Faculty or students from other universities are admitted if space permits.

Aalto students can sign up for the course using Oodi. Student without Aalto user account can sign up through MyCourses using the following URL and the enrolment key ASRM2021 (in capital letters):

https://mycourses.aalto.fi/enrol/index.php?id=33652

4 LEARNING OUTCOMES

The main goal of the course is to provide an overview of most commonly used data analysis techniques and research designs that go beyond cross-sectional designs and simple linear models. Instead of just explaining how the methods are used, we focus on why certain methods are used and how and why these methods work. We will also learn to interpret methodological evidence and go over basics of doing simulations to test or validate methods.

Completing the 6-credit base module will introduce you to the logic of structural equation models, generalized linear models, longitudinal data analysis, missing data, advanced measurement concepts, and endogeneity and causality.

The optional written assignments are more challenging and recommended only for those who plan to use the methods and designs covered in these assignments in their own research.

5 WORKLOAD

TO BE ADDED[2]. If you want to complete all mandatory and optional assignments on the course, you should book at least a day per week for the duration of the course.

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[2] Asko Karjalainen, Katariina Alha, and Suvi Jutila, *Anna Aikaa Ajatella: Suomalaisten Yliopisto-Opintojen Mitoitusjärjestelmä* (Oulun yliopisto, opetuksen kehittämisyksikkö, 2007).

6 COURSE CONTENT

The course consists of a pre-exam, readings and written assignments, data analysis assignments, video lectures, online interactions, seminar sessions, computer classes, a Monte Carlo project, and final exam. All assignments are distributed and returned through Aalto MyCourses where online interactions also take place.

https://mycourses.aalto.fi/course/view.php?id=33652

The course is structured as ten units that are completed sequentially. Unit 1 is a preparatory unit Units 2-8 are the main units, and Unit 10 is the course conclusion with student presentations and final exam.

The main units follow *primetime learning* model[3], modified to fit the course. In the primetime learning model, each unit has four different steps: principles, practice, problems and primetime as shown in Figure 1. The learning model is explained during the first seminar but participants are encouraged to read the article by Koskinen and coauthors to familiarize themselves with the model.

Figure 1 Primetime learning (Koskinen et al, 2018)

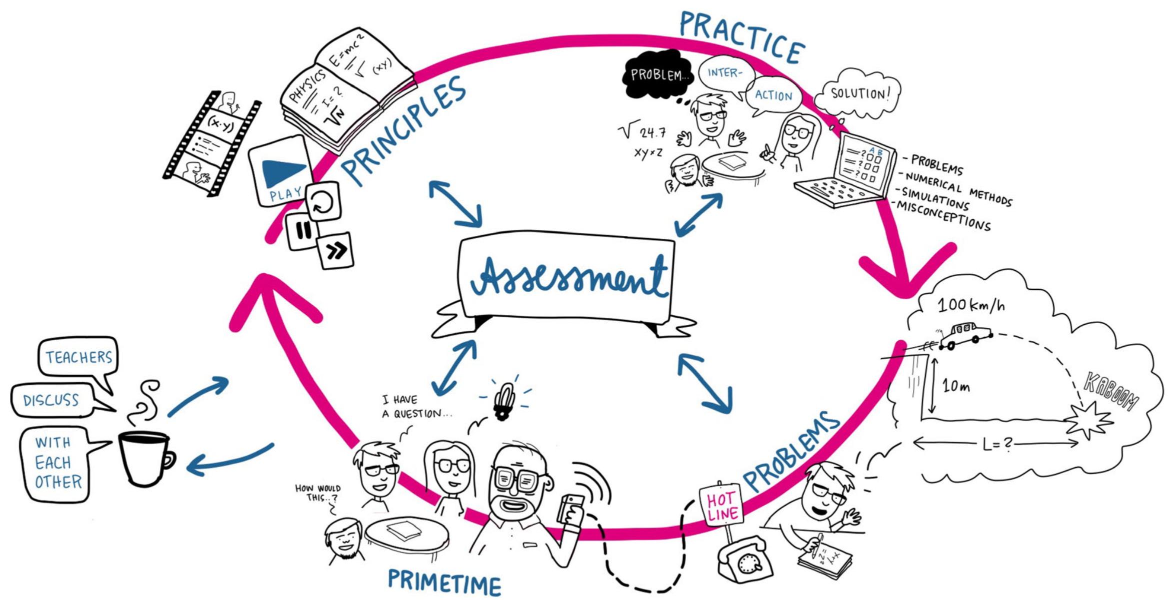

Fig. 2 Primetime learning model with the four-step study process: principles, practice, problems, and primetime. Formative assessment underlies the entire process and motivates students to perform activities that also directly affect the grade. This drawing is a succinct summary of the primetime model (drawing courtesy of Linda Saukko-Rauta)

Principles is the first step of a unit. During this step, the students receive a set of readings and video materials that they study independently. Written assignments are also completed and returned individually during this step.

After the students have studied the principles individually, we discuss them as a whole class. These discussions start on the course forum where possible questions and thoughts that the material raises are discussed. Thereafter, we will meet for a seminar for further discussions.

For the practice and problems steps the students are assigned into groups. Each group can decide on their own work practices and schedules, but share the same deadline for submitting the data analysis assignment.

Practice is when work on the data analysis assignment starts. The students should work on the assignment alone and complete those parts that they can. The assignments are challenging and it

[3] Pekka Koskinen et al., "Primetime Learning: Collaborative and Technology-Enhanced Studying with Genuine Teacher Presence," *International Journal of STEM Education* 5, no. 1 (December 2018), https://doi.org/10.1186/s40594-018-0113-8.

is not expected that students can complete them alone within a reasonable time. The purpose of this step is to gain experience on the use of statistical software and looking for information and solutions to problems online – both essential skills for an advanced quantitative researcher. The course forum can be used for general questions (e.g. which multilevel package for R is the best) but troubleshooting of problems should be done in the next step.

Problems step follows the practice step. In this step, the students meet with their groups, compare their answers to the data analysis assignment and try to solve problems that they had together. There is no traditional computer class but the teacher is available through WhatsApp/Signal hotline and guidance can be arranged over Zoom as needed. After working on the assignment together, the students prepare one submission and everyone in the group receives the same grade. The purpose of this part is to provide peer support and learn how to solve data analysis problems as a research team. More advanced students should also gain experience in instructing others, which is a useful skill to have when you move to a position where you need to instruct and supervise junior researchers such as doctoral students.

Primetime takes place after the group has submitted all the work. After viewing the model answers, each group schedules a Zoom meeting with the teacher to discuss their work and the challenges that they faced during the unit.

Detailed descriptions of the elements of the course are listed below:

6.1 Pre-exam (mandatory)

The pre-exam is a written exam that you must pass to be able to participate and get credits. The exam materials are

Singleton, R., & Straits, B. C. (2018). *Approaches to social research* (Sixth edition). New York: Oxford University Press.

Wooldridge, J. M. (2013). *Introductory econometrics: A modern approach* (5th ed). Mason, OH: South-Western Cengage Learning. Chapters 1-9.

Jaccard, J., & Jacoby, J. (2020). *Theory construction and model-building skills: A practical guide for social scientists* (Second edition). The Guilford Press. (Ebooks at Aalto and JYU)

and either of these books depending on whether you want to use Stata or R as your main statistical analysis software for the course:

StataCorp. (2021). *Stata user's guide*. College Station, TX: Stata Press. (PDF on Stata's website)

Wickham, H., & Grolemund, G. (2016). *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. O'Reilly Media, Inc. (Available online)

all reading materials of TU-L0021 Statistical Research Methods.

The exam consists of four questions. The first question is term definitions, in which you need to define 8 terms from the course material. The three remaining questions are essays. The exam questions are chosen randomly from a question pool that can be found on the course website.

Tips for studying for the exam: Wooldridge (2013) and Singleton and Straits (2018) should be already familiar to the students from the statistical research methods course and it should be sufficient to skim through these books to remember what they were about. Jaccard and Jacoby (2020) is new should be read in more detail focusing on Chapters 1-7, 13-17. The selected book about statistical software should be read cover to cover. After you have familiarized yourself with the materials, you should open the question pool on the course website and start going through the term definitions. When you see a term that you do not know how to define, you should seek the definition from the books. After this, you should do the same for the essay questions. If you have a clear idea on how you would answer a question, you can skip it and move on. If not, you should consult the books and perhaps write down a few bullet points of how you would answer the question.

6.2 Readings and written assignments (2 mandatory, 6 optional)

The written assignments consist of reading methodological literature and empirical papers and then doing an assignment where you apply the methodological ideas that you just studied to analyze the empirical papers. You will be provided individual feedback on the written assignments and these are discussed in both the online and in-person interactions.

Two written assignments 2 are. All returned written assignment should follow the American Psychological Association (APA) Publication Manual style for article manuscripts. All work will be checked for plagiarism using the TurnItIn service and will be returned to the students for revising if plagiarism problems are found.

6.3 Data-analysis assignments (8 mandatory)

Because the course is focused on doing quantitative analysis effectively, all data analysis assignments are mandatory. Each assignment contains three parts, tools, analyses, and challenge. The work on the assignment follows the primetime learning model, where students first work on the assignments individually and then go through their work and submit it as a group.

The tools part introduces you to general concepts such as reproducibility, programming your statistical software, data management, and visualization. Reproducibility refers to the being able to reproduce the exact analysis results presented in an article from the original raw data. Reproducibility can be compromised by poor data-analysis practices as well as by manual transferring of results from the statistical software to the research article.

Data management is an important skill of a quantitative researcher for two reasons. First, the raw data are typically in a different format than what the final analysis requires and thus some preparations are required before the actual analysis can even start. Second, the data preparation step is error prone and therefore it is important to know how to do data preparation in a transparent and reproducible way so that possible data preparation errors can be identified. Reproducibility can be increased by structuring all analyses as well-documented analysis files and by using the statistical software to produce the final tables shown in articles.

Data visualization is another important skill of a quantitative researcher. While good statistical software provides you with useful visualization tools (e.g. margins and marginsplot in Stata), there are scenarios where these tools are not applicable. For example, if you want to do a marginal effect or marginal prediction plot based on a latent variable model or a multilevel model, the built-in commands are often inadequate. Moreover, sometimes the impact of the different options and what they mean for the graphics may be difficult to evaluate.

The analyses part contains a series of short data-analysis tasks where the students apply the techniques discussed in the unit to either real or simulated dataset and interpret the results.

The challenge part contains one or two more challenging questions from the question pool of the final exam and can be useful for evaluating one's level of skill at various stages of the course.

Assignments can be done with either Stata or R. Some assignments can be also be completed partly with Mplus. Each assignment requires the submission of one or more files. The first file is commented analysis file (R file or Stata do file) that implements the analyses and a report that is produced using the reproducibility techniques taught on the course and also shows the analysis results and the required interpretations. In addition to the main analysis files, some assignments might require the submission of additional files such as Word and Excel documents.

All submissions receive verbal feedback during the primetime session.

6.4 Monte Carlo assignment (mandatory)

A Monte Carlo study is a study where repeated samples are generated from a known population which are then each analyzed with a technique being studied. This kind of studies are the most common form of evidence presented to support new data analysis techniques, but they are also useful for applied researchers, because a simple Monte Carlo can sometimes be enough to convince your readers and reviewers of the soundness of your empirics (e.g. a power analysis in the case of small-sample research). Simulations can also be useful when trying to learn a new analysis technique.

In the Monte Carlo assignment, the task is to pick a rule of thumb or a guideline and present evidence either supporting or refuting the rule. Examples of rules that you might study are:

- Variance inflation factor (VIF) should be less than ten to ensure that the estimates are interpretable.
- Control variables that are uncorrelated with the dependent variable should be left out from a regression model[4].
- Approximate fit indices indicating RMSEA < .06 and CFI > .95 indicate a good fitting model that can be causally interpreted.
- Regression analysis requires the error term to be normally distributed.
- Common method variance will always inflate regression estimates.
- Measurement error will always attenuate regression estimates.

The Monte Carlo studies are reported as short presentations (15 minutes) that are given in the last seminar session by the students. The grading is based on presentation and the submitted analysis file that implements the simulation.

The purpose of this assignment is to familiarize the students with the programming features of their statistical software and to learn how methodological evidence is generated and interpreted.

6.5 Presentation of a methodological paper (mandatory)

In this assignment, the students pick an article published in *Organizational Research Methods* during the last three years. The article should be chosen based on how useful or thought provoking you found the article to be. The articles that are discussed in detail on the course cannot be picked. Read through the article and prepare a 15-minute presentation of the article that you will give to the other students during the last seminar.

The purpose of this assignment is to familiarize you with the kind of research that *Organizational Research Methods* publishes and how articles presented in this journal should be read and interpreted. This is useful if you want to keep yourself up to date with the latest developments in research methods that are applied in management research.

6.6 Video lectures (mandatory and optional)

The course follows a flipped classroom design and the lectures are delivered as videos that students watch on their own before online and in-person meetings with the instructor.

Each of the videos is assigned to a unit and the completion of watching the videos is tracked so that a student can complete a unit only if they have watched all mandatory videos for that unit. Some videos may contain interactive content (e.g. quizzes) that must be completed successfully to complete the video.

[4] e.g., Herman Aguinis and Robert J. Vandenberg, “An Ounce of Prevention Is Worth a Pound of Cure: Improving Research Quality Before Data Collection,” *Annual Review of Organizational Psychology and Organizational Behavior* 1, no. 1 (2014): 574, https://doi.org/10.1146/annurev-orgpsych-031413-091231.

6.7 Online interactions (mandatory)

Each unit contains mandatory online participation in the form of course forum discussion. At the beginning of each unit, the students are assigned the materials for that unit including readings, assignments, and video content. After a few days of familiarizing with the content, students are expected to post a question or a comment about the materials on the course forum. These questions and comments are then discussed online with the course instructor. To pass an online interaction session, a student must either start at least one discussion thread by posting a question or comment or reply to at least one thread started by someone else. Participation is graded.

Detailed instructions for how to participate online are delivered by email when the course forums open.

6.8 Seminar sessions (mandatory)

Each unit except the first one has a Zoom seminar. These seminars follow a flipped classroom design. Each seminar starts with an overview of the lecture materials that the students have viewed as videos in advance, but the focus is more on discussion and classroom assignments.

The final seminar session includes student presentations of their Monte Carlo projects and chosen articles.

6.9 Final exam (mandatory)

The course concludes with a final exam. The exam is done using either Stata and R and the answers are submitted as a report similar to the assignment reports. The exam will require the students to carry out and interpret analyses on datasets given by the instructor, troubleshooting problematic analyses, finding problems in analyses and research designs reported by others, and so on. The exam is an open book exam and the students can use their notes, written material, and internet, but they may not communicate with each other or anyone else over the internet.

The exam time is 4 hours.

7 UNITS AND SCHEDULE

The course consists of ten units. Each unit starts with a self-study of the materials, followed by online interactions where the materials are discussed on the course forum, a seminar, and group work on the assignment concluding with the primetime session.

Because of the pandemic, the course will be implemented fully online. If the pandemic situation allows, the course has also an alternative schedule prepared for in-person seminars.

Date	Time	Location	Topic
Unit 1: Course introduction and pre-exam Weeks 36-38			
6.9.	8:00	Online	Course forum for unit 1 opens. The task is to write a forum post where you introduce yourself to others on the course.
6.9.- 5.10		Exam system	Course pre-exam
Unit 2: Causality, endogeneity, and natural experiments Weeks 39-41			
27.9.	8:00	Online	Course forum for unit 2 opens.
4.10.	24:00	Online	Deadline for written assignment 1 (mandatory)
6.10.	9:15-12	Online	Unit 2 seminar

17.10.	24:00	Online	Deadline for data-analysis assignment 1
Unit 3: Structural equation modeling, mediation, and instrumental variables Weeks 42-44			
18.10.	8:00	Online	Course forum for unit 3 opens.
25.10.	24:00	Online	Deadline for written assignment 2 (mandatory)
27.10.	9:15-12	Online	Unit 3 seminar
7.11.	24:00	Online	Deadline for data-analysis assignment 2
Unit 4: Moderation, transformations, and generalized linear models Weeks 45-47			
8.11.	8:00	Online	Course forum for unit 4 opens.
15.11.	24:00	Online	Deadline for written assignment 3 (optional)
17.11.	9:15-12	Online	Unit 4 seminar
28.11.	24:00	Online	Deadline for data-analysis assignment 3
Unit 5: Structural equation modeling with latent variables Week 48-50			
29.11.	8:00	Online	Course forum for unit 5 opens.
6.12.	24:00	Online	Deadline for written assignment 4 (optional)
8.12.	9:15-12	Online	Unit 5 seminar
19.12.	24:00	Online	Deadline for data-analysis assignment 4
Unit 6: Measurement and measurement validation Week 2-4			
10.1.	8:00	Online	Course forum for unit 6 opens.
17.1	24:00	Online	Deadline for written assignment 5 (optional)
19.1.	9:15-12	Online	Unit 6 seminar
30.1.	24:00	Online	Deadline for data-analysis assignment 5
Unit 7: Multilevel models Weeks 6-8			
7.2.	8:00	Online	Course forum for unit 7 opens.
14.2.	24:00	Online	Deadline for written assignment 6 (optional)
16.2.	9:15-12	Online	Unit 7 seminar
27.2.	24:00	Online	Deadline for data-analysis assignment 6
Unit 8: Longitudinal analysis and multilevel SEM Weeks 10-12			
7.3.	8:00	Online	Course forum for unit 8 opens.
14.3.	24:00	Online	Deadline for written assignment 7 (optional)
16.3.	9:15-12	Online	Unit 8 seminar
27.3.	24:00	Online	Deadline for data-analysis assignment 7

Unit 9: Sampling, sample selection, and missing data Weeks 14-16			
4.4.	8:00	Online	Course forum for unit 9 opens.
11.4.	24:00	Online	Deadline for written assignment 8 (optional)
13.4.	9:15-12	Online	Unit 9 seminar
24.4.	24:00	Online	Deadline for data-analysis assignment 8
Unit 10: Student presentations and course conclusion Weeks 17-19			
2.5.	24:00	Online	Deadline for Monte Carlo assignment
4.5.	9:15-17	Online	Unit 10 seminar with student presentations
Final exam Week 22			
TBA	TBA	Aalto	Final exam
TBA	TBA	JYU	

The detailed description of the ten units follows.

7.1 Unit 1: Course introduction

The purpose of this unit is to introduce the students to the work practices on the course. The students may not be familiar with working on a blended learning / online course or the primetime learning model, and this first unit will introduce the course tools (MyCourses/Moodle, Zotero, TurnItIn, Zoom) and work practices.

The unit concludes with the course pre-exam.

7.2 Unit 2: Causality, endogeneity, and natural experiments

Research designs and techniques:

The unit discusses assumptions and principles behind making causal claims. We briefly cover different philosophical approaches for causation after which we focus on the counterfactual model. The average causal (treatment) effect is contrasted with other possible ways to define causal effects.

We also cover natural experimental designs for making causal claims. Difference-in-differences, propensity score matching, and regression discontinuity models are introduced as statistical tools for causal analysis.

The concept of endogeneity and why it presents a dilemma is discussed. We discuss the use of instrumental variables to address endogeneity and the instrument relevance and exclusion criterions.

Computer tools:

Besides the analysis techniques presented during this unit, the computer assignment addresses random number generation and reproducibility. Generating random numbers is a useful skill because it allows one to generate datasets from known populations and then test if a particular analysis technique can recover the correct population values. This is useful for example when you are learning new analysis techniques or are troubleshooting existing analyses (e.g. checking for model identification).

This unit introduces Markdown and StatTag[5] to automate linking analysis results to research reports as well as how to export results in CSV or Excel format so that they can be copy-pasted to research reports as full tables.

Readings:

Hitchcock, C. (2010). Causation. In S. Psillos & M. Curd (Eds.), *The Routledge companion to philosophy of science* (1. publ. in paperback, pp. 317–326). London: Routledge.

Morgan, S. L., & Winship, C. (2007). *Counterfactuals and causal inference methods and principles for social research*. Leiden: Cambridge University Press. (Chapters 1-2)

Wooldridge, J. M. (2013). *Introductory econometrics: a modern approach* (5th ed.). Mason, OH: South Western, Cengage Learning. (Chapter, 15)

Athey, S., & Imbens, G. W. (2017). The state of applied econometrics: Causality and policy evaluation. *Journal of Economic Perspectives*, 31(2), 3–32.

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. https://doi.org/10.1016/j.jom.2017.05.001

Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, 21(6), 1086-1120. doi:10.1016/j.leaqua.2010.10.010

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. https://doi.org/10.1016/j.jom.2018.10.003

Empirical examples:

Mochon, D., Johnson, K., Schwartz, J., & Ariely, D. (2017). What Are Likes Worth? A Facebook Page Field Experiment. *Journal of Marketing Research (JMR)*, 54(2), 306–317.

Cuddy, A. J. C., Wilmuth, C. A., Yap, A. J., & Carney, D. R. (2015). Preparatory power posing affects nonverbal presence and job interview performance. *Journal of Applied Psychology*, 100(4), 1286–1295. https://doi.org/10.1037/a0038543

Optional readings:

Deaton, A., & Cartwright, N. (2018). Understanding and misunderstanding randomized controlled trials. *Social Science & Medicine*, 210, 2–21. https://doi.org/10.1016/j.socscimed.2017.12.005

Sieweke, J., & Santoni, S. (2019). Natural experiments in leadership research: An introduction, review, and guidelines. *The Leadership Quarterly*, 101338. https://doi.org/10.1016/j.leaqua.2019.101338

Singleton, R., & Straits, B. C. (2018). Approaches to social research (Sixth edition). Oxford University Press. Chapter 8

7.3 Unit 3: Structural equation modeling, mediation, and instrumental variables

Research designs and techniques:

This unit explains the basic principles of structural equation modeling with observed variables for independent observations (e.g. a cross-sectional study). We discuss identification, estimation, interpretation, and diagnostics. The focus will be on maximum likelihood (ML) estimation.

[5] Leah J Welty et al., *StatTag* (Chicago, IL: Galter Health Science Library, 2016), https://doi.org/10.18131/G36K76.

Mediation is introduced in more detail including estimation of models with endogenous mediators.

We discuss further instrumental variable techniques including estimation of instrumental variable models with ML SEM, generalized method of moments (GMM), and two-stage least squares. Tests for endogeneity, weak instruments, and instrument exclusion are introduced as is the concept of plausible exogeneity.

Computer tools:

This unit introduces two new tools: matrix algebra and numerical optimization. Understanding the basics of matrix algebra is useful for two reasons. First, many texts on quantitative methods that go beyond introductory level use matrix notation if not in full then at least in part. If you understand how to read matrix equations and what these equations mean, this will make it easier to study these sources. Second, if you are generating datasets yourself, doing that with matrix equations instead of writing a separate (scalar) equation for each variable is much more straightforward. The introduction covers the topics of matrix sums, matrix multiplication, inverse, and determinant.

Every statistical model addressed on the course is estimated by minimizing and objective function. While some techniques, such as least-squares regression, has a closed from solution which can be simply calculated by applying algebra to the data, most other techniques do not. In these cases, the estimates are obtained by numerically minimizing or maximizing the objective function. This unit covers the basics of numerical optimization and how gradient vector and Hessian matrix are used in this process and can be used for troubleshooting non-convergent models.

Readings:

Kline, R. B. (2011). Principles and practice of structural equation modeling (3rd ed.). New York, NY: Guilford Press. (Chapters 1, 5-8, 153 pages)

Lu, G., Ding, X. (David), Peng, D. X., & Hao-Chun Chuang, H. (2018). Addressing endogeneity in operations management research: Recent developments, common problems, and directions for future research. *Journal of Operations Management.* https://doi.org/10.1016/j.jom.2018.10.001

Empirical examples:

Bergh, D. D., Aguinis, H., Heavey, C., Ketchen, D. J., Boyd, B. K., Su, P., … Joo, H. (2016). Using meta-analytic structural equation modeling to advance strategic management research: Guidelines and an empirical illustration via the strategic leadership-performance relationship. *Strategic Management Journal*, *37*(3), 477–497. https://doi.org/10.1002/smj.2338

Hekman, D. R., Aquino, K., Owens, B. P., Mitchell, T. R., Schilpzand, P., & Leavitt, K. (2010). An Examination of Whether and How Racial and Gender Biases Influence Customer Satisfaction. *Academy of Management Journal*, *53*(2), 238–264. https://doi.org/10.5465/AMJ.2010.49388763

Eshima, Y., & Anderson, B. S. (2017). Firm growth, adaptive capability, and entrepreneurial orientation. *Strategic Management Journal*, *38*(3), 770–779. https://doi.org/10.1002/smj.2532

Optional readings:

Cortina, J. M., Green, J. P., Keeler, K. R., & Vandenberg, R. J. (2017). Degrees of Freedom in SEM: Are We Testing the Models That We Claim to Test? *Organizational Research Methods*, *20*(3), 350–378. https://doi.org/10.1177/1094428116676345

Kline, R. B. (2015). The mediation myth. *Basic and Applied Social Psychology*, 37(4), 202–213. https://doi.org/10.1080/01973533.2015.1049349

Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, 21(6), 1086-1120. doi:10.1016/j.leaqua.2010.10.010

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. https://doi.org/10.1016/j.jom.2017.05.001

7.4 Unit 4: Moderation, transformations, and generalized linear models

Research designs and techniques:

We discuss the use of linear regression to estimate moderation models and how transformations can be used for modeling non-linear effects.

The unit introduced the generalized linear model, which is an extension to linear regression covering most commonly used single dependent variable models as special cases (e.g. logistic regression, Poisson regression, tobit regression, etc.). Maximum likelihood estimation of these models is introduced.

We will focus on the choice of non-linear model as well as their graphical interpretation and common non-graphical interpretations including their misuses.

Computer tools:

The computer tools covered in this unit are about visualization. We will focus particularly on two-way plots and their application for calculating marginal prediction and marginal effects plots. These plots are produced by both the built-in plots (e.g. margins in Stata) as well as without these tools by using generic graphing functions.

Readings:

Wooldridge, J. M. (2013). *Introductory econometrics: a modern approach* (5th ed.). Mason, OH: South Western, Cengage Learning. (Chapters 6-8, 17)

Dawson, J. F. (2014). Moderation in management research: What, why, when, and how. *Journal of Business and Psychology*, *29*(1), 1–19. https://doi.org/10.1007/s10869-013-9308-7

Rönkkö, M., Aalto, E., Tenhunen, H., & Aguirre-Urreta, M. I. (2021). Eight simple guidelines for improved understanding of transformations and nonlinear effects. *Organizational Research Methods*, 1094428121991907. https://doi.org/10.1177/1094428121991907

Empirical examples:

Hekman, D. R., Aquino, K., Owens, B. P., Mitchell, T. R., Schilpzand, P., & Leavitt, K. (2010). An Examination of Whether and How Racial and Gender Biases Influence Customer Satisfaction. *Academy of Management Journal*, 53(2), 238-264. doi:10.5465/AMJ.2010.49388763

Antonakis, J., Bastardoz, N., Liu, Y., & Schriesheim, C. A. (2014). What makes articles highly cited? The Leadership Quarterly, 25(1), 152–179. https://doi.org/10.1016/j.leaqua.2013.10.014

7.5 Unit 5: Structural equation modeling with latent variables

Research designs and techniques:

The unit introduces students to structural equation models with both latent and observed variables for cross-sectional designs. Structural equation models are a basic tool in the course and many of the techniques covered can be considered as special cases of this general modeling framework.

Different techniques for analyzing latent interactions are presented. Estimation techniques other than ML are introduced (MIIV, WLS).

Various diagnostics and model fit indices are discussed.

Computer tools:

This unit introduces loops, which allow automating repetitive tasks in statistical software. Loops are used for example to construct and export tables of model fit indices. Such tables are not available for export directly from the software that we use, but must be constructed manually.

We also continue practicing matrix calculations and troubleshoot problematic models by inspecting the output of numerical optimization routines of statistical software.

Readings:

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York, NY: Guilford Press. (Chapter 5-9, 10, 12)

Ropovik, I. (2015). A cautionary note on testing latent variable models. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.01715

Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, *21*(6), 1086–1120. doi:10.1016/j.leaqua.2010.10.010

Empirical examples:

Mesquita, L. F., & Lazzarini, S. G. (2008). Horizontal and Vertical Relationships in Developing Economies: Implications for Smes' Access to Global Markets. *Academy of Management Journal*, *51*(2), 359–380.

Yli-Renko, H., Autio, E., & Sapienza, H. J. (2001). Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. *Strategic Management Journal*, *22*(6-7), 587–613. doi:10.1002/smj.183

7.6 Unit 6: Measurement and measurement validation

Research designs and techniques:

Measurement related problems, particularly in studies where data are collected with surveys, are some of the most common reasons for rejecting manuscripts from publication. In this unit we will address issues related to reliability, validity, and measurement modeling.

A fairly typical way of addressing reliability in empirical research is to first calculate "Cronbach's alphas" that are then compared against fixed 0.70 cutoff. If all alphas exceed 0.70, reliability is declared acceptable and then ignored for the remainder of the article. This practice is problematic for two main reasons: alpha is rarely the best reliability index and reliability assessment is not a yes or no decision. We will discuss different reliability indices and their assumptions and how reliability statistics and the effect of unreliability can be interpreted and quantified beyond using fixed benchmarks. The concept of bi-factor model is introduced to support the discussion.

The concept of validity is more challenging. We will discuss a couple of different measurement theories and how these relate to current (psychometric) modeling practices. The problematic concepts of formative measurement and multidimensional constructs are discussed.

Common method variance is another issue that is often raised during the review process of survey-based research. We will discuss the different potential causes of this phenomenon, what different statistical approaches are available to detect and possibly control for method variance, and why most of these techniques are actually inadequate for the task.

Finally, we will also discuss what to do when a structural equation model does not fit or fails to converge. Exploratory structural equation models and Bayesian structural equation models are introduced as possible solutions for relaxing the strict covariance implications of traditional linear structural equation models.

Computer tools:

This unit discusses programming and data management. We discuss how data can be merged and reshaped and how repetitive tasks can be automated with programs (Stata) and functions (R).

Readings:

DeVellis, R. F. (2017). *Scale development theory and applications* (4th ed.). Thousand Oaks: Sage. (Chapters 1-4, 6-7)

Borsboom, D., Mellenbergh, G. J., & van Heerden, J. (2004). The concept of validity. *Psychological Review*, *111*(4), 1061.

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York, NY: Guilford Press. (Chapter 8)

McNeish, D. (2017). Thanks Coefficient Alpha, We'll Take It From Here. *Psychological Methods*. https://doi.org/10.1037/met0000144

Rönkkö, M., & Cho, E. (2019). Discriminant validity: A synthesis of definitions and a test of techniques. *Organizational Research Methods*.

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of Method Bias in Social Science Research and Recommendations on How to Control It. *Annual Review of Psychology*, *63*(1), 539–569. https://doi.org/10.1146/annurev-psych-120710-100452

Empirical examples:

Kohtamäki, M., Kraus, S., Mäkelä, M., & Rönkkö, M. (2012). The role of personnel commitment to strategy implementation and organisational learning within the relationship between strategic planning and company performance. *International Journal of Entrepreneurial Behavior & Research*, *18*(2), 159–178. https://doi.org/10.1108/13552551211204201

7.7 Unit 7: Multilevel models

Research designs and techniques:

Independence of observations is one of the key assumptions of linear regression. However, this assumption is violated when working with longitudinal or clustered data (i.e. members in teams) because of unobserved heterogeneity. We start by introducing the concepts of nested and crossed clustering, the between, within, and contextual effects, and the concepts of random and fixed effects.

The data-analysis techniques covered include GLS random and fixed effects estimators and the Mundlak/correlated random effect/hybrid approach from the econometrics tradition for analyzing these types of data and mixed/random/multilevel models from the modeling tradition. Generalized estimation equations and cluster robust standard errors are presented as an alternative to these techniques. Additionally, we discuss the use of cluster means or cluster mean centering for estimating effects on different levels. Different empirical approaches for model choice (Hausman test and different nested model tests) are presented. The data analysis techniques conclude with models for cross-level interactions and generalized mixed models.

Finally, we will also discuss what to do when a multilevel model fails to converge.

Computer tools:

This unit will teach the students how to run Monte Carlo simulations how to summarize the Monte Carlo results as tables and figures.

Readings:

Luke, D. A. (2004). *Multilevel Modeling*. Sage. (Chapters 1, 2)

Wooldridge, J. M. (2013). *Introductory econometrics: A modern approach* (5th ed). South-Western Cengage Learning. (Chapters 9.2, 13, 14)

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological Methods*, *22*(1), 114–140. https://doi.org/10.1037/met0000078

Antonakis, J., Bastardoz, N., & Rönkkö, M. (2019). On ignoring the random effects assumption in multilevel models: Review, critique, and recommendations. *Organizational Research Methods*, 1094428119877457. https://doi.org/10.1177/1094428119877457

Empirical examples:

Holcomb, T. R., Combs, J. G., Sirmon, D. G., & Sexton, J. (2010). Modeling Levels and Time in Entrepreneurship Research An Illustration With Growth Strategies and Post-IPO Performance. *Organizational Research Methods*,*13*(2), 348–389. doi:10.1177/1094428109338401

Hausknecht, J. P., Hiller, N. J., & Vance, R. J. (2008). Work-Unit Absenteeism: Effects of Satisfaction, Commitment, Labor Market Conditions, and Time. *Academy of Management Journal*, *51*(6), 1223–1245. doi:10.5465/AMJ.2008.35733022

Deephouse, D. L. (1999). To be different, or to be the same? It's a question (and theory) of strategic balance. *Strategic Management Journal*, *20*(2), 147–166.

Mochon, D., Johnson, K., Schwartz, J., & Ariely, D. (2017). What Are Likes Worth? A Facebook Page Field Experiment. *Journal of Marketing Research (JMR)*, *54*(2), 306–317.

Optional readings:

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2016). On the Unnecessary Ubiquity of Hierarchical Linear Modeling. *Psychological Methods*. http://dx.doi.org/10.1037/met0000078

Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly*, *21*(6), 1086–1120. doi:10.1016/j.leaqua.2010.10.010

Ketokivi (2019) Avoiding Bias and Fallacy in Survey Research: A Behavioral Multilevel Approach. *Journal of Operations Management*

Bou, J. C., & Satorra, A. (2017). Univariate Versus Multivariate Modeling of Panel Data: Model Specification and Goodness-of-Fit Testing. *Organizational Research Methods*, 109442811771550. https://doi.org/10.1177/1094428117715509

Bliese, P. D., & Ployhart, R. E. (2002). Growth Modeling Using Random Coefficient Models: Model Building, Testing, and Illustrations. *Organizational Research Methods*, *5*(4), 362–387. https://doi.org/10.1177/109442802237116

Aguinis, H., Gottfredson, R. K., & Culpepper, S. A. (2013). Best-Practice Recommendations for Estimating Cross-Level Interaction Effects Using Multilevel Modeling. *Journal of Management*, *39*(6), 1490–1528. https://doi.org/10.1177/0149206313478188

7.8 Unit 8: Longitudinal analysis and multilevel SEMs

Research designs and techniques:

Longitudinal analysis can refer to either studying the effects of time on the dependent variable or studying the effect of the dependent variable itself on its future values. This unit introduces the concepts of lagged dependent variables, and the choice of lags more generally, autocorrelation, dynamic panel models, and endogeneity in panel models.

The econometrics techniques cover the use of instrumental variables to address the endogeneity issue in dynamic panels, particularly by using the Arellano-Bond approach. Longitudinal analysis with structural equation models are covered using the latent growth model, cross-lagged model and its variants, and latent change score models.

Stata's generalized structural equation modeling and other approaches to multilevel structural equation modeling, including the MUML and WLSMV estimators as implemented in Mplus and Lavaan are presented. Longitudinal latent class analysis is introduced briefly.

Computer tools:

Besides the analysis techniques discussed in this unit, there will be no new computer tools. The students will have an opportunity to ask questions and get guidance on their Monte Carlo projects.

Readings:

Bliese, P. D., & Ployhart, R. E. (2002). Growth Modeling Using Random Coefficient Models: Model Building, Testing, and Illustrations. *Organizational Research Methods*, *5*(4), 362–387. https://doi.org/10.1177/109442802237116

Ketokivi (2019) Avoiding Bias and Fallacy in Survey Research: A Behavioral Multilevel Approach. *Journal of Operations Management*

Antonakis, J., Bastardoz, N., & Rönkkö, M. (2019). On ignoring the random-effects assumption in multilevel models: Review, critique, and recommendations. *Organizational Research Methods*, *forthcoming*.

Bou, J. C., & Satorra, A. (2017). Univariate Versus Multivariate Modeling of Panel Data: Model Specification and Goodness-of-Fit Testing. *Organizational Research Methods*, 109442811771550. https://doi.org/10.1177/1094428117715509

Aguinis, H., Gottfredson, R. K., & Culpepper, S. A. (2013). Best-Practice Recommendations for Estimating Cross-Level Interaction Effects Using Multilevel Modeling. *Journal of Management*, *39*(6), 1490–1528. https://doi.org/10.1177/0149206313478188

Little, T. D. (Ed.). (2013). *The Oxford handbook of quantitative methods* (Vol. 2). New York: Oxford University Press. (Chapter 18)

Hamaker, E. L., Kuiper, R. M., & Grasman, R. P. (2015). A critique of the cross-lagged panel model. *Psychological Methods*, *20*(1), 102–116.'

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York, NY: Guilford Press. (Chapter 11)

Ployhart, R. E., & Vandenberg, R. J. (2010). Longitudinal Research: The Theory, Design, and Analysis of Change. *Journal of Management*, *36*(1), 94–120. https://doi.org/10.1177/0149206309352110'

Wooldridge, J. M. (2013). *Introductory econometrics: a modern approach* (5th ed.). Mason, OH: South Western, Cengage Learning. (Chapters 13.2)

Wu, W., Selig, J. P., & Little, T. D. (2013). Longitudinal data analysis. In T. D. Little (Ed.), *The Oxford handbook of quantitative methods* (Vol. 2, pp. 387–410). Oxford University Press.

Empirical example:

Meier, L. L., & Spector, P. E. (2013). Reciprocal effects of work stressors and counterproductive work behavior: A five-wave longitudinal study. *Journal of Applied Psychology*, *98*(3), 529-539.

7.9 Unit 9: Sampling, sample selection, and missing data

Research designs and techniques:

Missing data refers to a phenomenon where part of the data that would be ideally be available for an analysis is in fact not available. Sample selection is a special case of missing data where the missingness depends systematically on the studied phenomenon. A classic example is a study of how strongly women's income depend on their level of education. Studying this effect is challenging because some women choose to not work and stay at home with the children and this decision depends on the income that they would receive from the job markets.

This unit starts by introducing the three different missing data mechanisms, missing completely at random (MCAR), missing at random (MAR), and missing not at random (MNAR) and different missing data patterns. After this, we will discuss when and why missing data could become a problem and how a potential missing data or sample selection issue can be diagnosed.

Multiple imputation and maximum likelihood estimation with missing data (FIML) are presented as solutions to the MCAR and MAR scenarios. Selection models, including the widely used Heckman model, are presented as a potential solution to MCAR scenarios, focusing particularly on the assumptions that these techniques make and the fact that sometimes these assumptions may be more untenable than the MAR assumption.

Finally, we will discuss endogenous selection where data are not missing, but where a selection into a group depends on the dependent variable. For example, companies do not makes a decision randomly but based on the company's expected returns from that decision.

Computer tools:

Besides the analysis techniques discussed in this unit, there will be no new computer tools. The students will have an opportunity to ask questions and get guidance on their Monte Carlo projects.

Readings:

Wooldridge, J. M. (2013). *Introductory econometrics: a modern approach* (5th ed.). Mason, OH: South Western, Cengage Learning. (Chapters 9.5, 17.1, 17.4, 17.5)

Baraldi, A. N., & Enders, C. K. (2013). Missing data methods. In T. D. Little (Ed.), *The Oxford handbook of quantitative methods* (Vol. 2, pp. 635–664). Oxford University Press.

Enders, C. K. (2010). *Applied missing data analysis*. New York: Guilford Publications. (Chapters 1-4, 10)

Clougherty, J. A., Duso, T., & Muck, J. (2016). Correcting for self-selection based endogeneity in management research: Review, recommendations and simulations. *Organizational Research Methods*, *19*(2), 286–347. https://doi.org/10.1177/1094428115619013

Rogelberg, S. G., & Stanton, J. M. (2007). Introduction Understanding and Dealing With Organizational Survey Nonresponse. *Organizational Research Methods,* 10(2), 195–209. https://doi.org/10.1177/1094428106294693

Newman, D. A. (2014). Missing Data Five Practical Guidelines. *Organizational Research Methods*, 17(4), 372–411. https://doi.org/10.1177/1094428114548590

Certo, S. T., Busenbark, J. R., Woo, H., & Semadeni, M. (2016). Sample selection bias and Heckman models in strategic management research. *Strategic Management Journal*, *37*(13), 2639–2657. https://doi.org/10.1002/smj.2475

Empirical examples:

Egan, M., Daly, M., Delaney, L., Boyce, C. J., & Wood, A. M. (2017). Adolescent conscientiousness predicts lower lifetime unemployment. *Journal of Applied Psychology*, *102*(4), 700–709. https://doi.org/10.1037/apl0000167

Gooderham, P., Fenton-O'Creevy, M., Croucher, R., & Brookes, M. (2018). A Multilevel Analysis of the Use of Individual Pay-for-Performance Systems. *Journal of Management*, *44*(4), 1479–1504. https://doi.org/10.1177/0149206315610634

Mansour, S., & Tremblay, D.-G. (2019). How can we decrease burnout and safety workaround behaviors in health care organizations? The role of psychosocial safety climate. *Personnel Review*, *48*(2), 528–550. https://doi.org/10.1108/PR-07-2017-0224

7.10 Unit 10: Student presentations and course conclusion

The seminar has two sets of student presentations. Each student is required to read one recent article from *Organizational Research Methods* and present that in the class. Additionally, the students present their Monte Carlo simulations. We will also have time for general discussion on research methods and doing research.

8 GRADING

All submitted work will be graded between 1-5 and your grade will be a weighted average of the parts of the course that you completed.

Course part	Weight	Notes
Pre-exam	5	
Seminar and forum participation	1 each (total 9)	By default, you will receive 2 for posting something on the course forum or being present at a seminar and your grade will increase based on your participation
Final exam	16	
Assignments	1 each (total 17)	8 data analysis assignments, 8 written assignments, 1 methodological article presentation.
Project	3	1 Monte Carlo project presentation
Total	50	

9 COURSE MATERIAL

The reading materials for the course are distributed through the Zotero reference management system. To get access to the materials:

1. Create a user account at Zotero.org
2. Email your username to the course instructor
3. The course instructor will send you an invitation to a group library, which you need to accept.

After you have accepted the invitation, you can access the material either online with a web browser or by installing the Zotero software on your computer. See the MyCourses page for information.

9.1 Books

To be added.

XX pages total.

9.2 Articles

To be added.

XX pages total.

9.3 Empirical articles used as examples

To be added.

XX pages total.

10 ABOUT THE INSTRUCTOR

The course is taught by Dr. Mikko Rönkkö. He is Associate Professor of Entrepreneurship at Jyväskylä University School of Business and Economics and Docent in Management at Aalto University. His work focuses on the use of quantitative research methods in management and and on growth entrepreneurship. He has published articles about quantitative research methods in multiple journals including leading applied research methods journals, (e.g. Organizational Research Methods, Psychological Methods), and leading field journals (e.g. Journal of Operations Management and MIS Quarterly), and has taught quantitative research methods at multiple universities in and outside Finland. He has served as a department editor at Journal of Operations Management and on the editorial boards of Organizational Research Methods and Entrepreneurship Theory and Practice.