Syllabus

Measurement Error Models
1 credits / 2 ECTS

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Video lectures by
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June 7 – June 28, 2021

Short Course Description

Surveys reflect the opinions or facts researchers are after only partly – the other part will be measurement error, which can seriously bias analyses of interest. To remove such biases it is essential to estimate the extent of measurement error in survey variables, which is precisely the goal of *statistical measurement error modeling*. In this course, we will discuss how measurement error can be defined, how its presence can be detected using specialized data collection designs and models, and how to perform error-corrected statistical analyses of substantive interest.

Course Objectives

By the end of the course, students will be able to…
1. **Define measurement error** conceptually, including the concepts of reliability and validity;
2. **Explain** the different approaches to estimating measurement error and their respective advantages and drawbacks;
3. **Interpret** the results of statistical models used to estimate measurement error in the absence of a gold standard;
4. **Perform regression analyses** from which the influence of measurement error has been removed and interpret the results.

Prerequisites

- Knowledge of basic statistics including regression analysis;
- Ability to run an R script, for example from RStudio; a cursory understanding of R;
- In-depth knowledge of R or latent variable models is **NOT** required.

Class Structure and Course Concept

This is an online course using a flipped classroom design. It covers the same material and content as an on-site course but runs differently. In this course, you are responsible for watching video-recorded lectures and reading the required literature for each unit prior to participating in mandatory weekly one-hour online meetings where students have the chance to discuss the materials from a unit with the instructor. Just like in an on-site course, homework will be assigned and graded and there will be a final exam at the end of the course.

Although this is an online course where students have more freedom in when they engage with the course materials, students are expected to spend the same amount of time overall on all activities in the course – including preparatory activities (readings, studying), in-class-activities (watching prerecorded videos, attending the live online meetings), and follow-up activities (working on assignments and exams) – as in an on-site course. As a rule of thumb, you can expect to spend approximately 3h/week on in-class-activities and 9 hours per week on out-of-class activities (preparing for class, readings, assignments, projects, studying for quizzes and exams). Therefore, the workload in all courses will be approximately 12h/week. Please note that the actual workload will depend on your personal knowledge.

Mandatory Weekly Online Meetings

Monday, 12:00 – 12:50 PM EDT / 6:00 – 6:50 PM CEST, starting June 7, 2021
Meetings will be held online through Zoom. Follow the link to the meeting sessions on the course website on [mannheim.instructure.com.](mannheim.instructure.com) If video participation via Internet is not possible, arrangements can be made for students to dial in and join the meetings via telephone.

In preparation for the weekly online meetings, students are expected to watch the lecture videos and read the assigned literature before the start of the meeting. In addition, students are encouraged to post questions about the materials covered in the videos and readings of the week in the forum before the meetings (deadline for posting questions is Friday, 6:00 AM EDT/12:00 PM CEST).

Students have the opportunity to use the Conferences feature in Canvas to connect with peers outside the scheduled weekly online meetings (e.g., for study groups). Students are not required to use Canvas Conferences and can of course use other online meeting platforms such as Google Hangouts, Skype or Microsoft Teams.

Grading

Grading will be based on:
- 3 short online quizzes (worth 20% total)
- 3 weekly homework assignments (worth 20% total)
- Participation in discussion during the weekly online meetings and demonstrating understanding of the required readings and video lectures (10% of grade)
- A final open-book online exam (50% of grade)

Dates of when assignment will be due are indicated in the syllabus. Late assignments will not be accepted without prior arrangement with the instructor.

A+	100 - 97
A	96 - 93
A-	92 - 90
B+	89 - 87
B	86 - 83
B-	82 - 80
Etc.	

The grading scale is a base scale recommended by the MDM. Variations for grading on a scale are at the discretion of the instructor.

The final grade will be communicated under the assignment "Final Grade" in the Canvas course. Please note that the letter grade written in parentheses in Canvas is the correct final grade. The point-grade

displayed alongside the letter grade is irrelevant and can be ignored. Dates of when assignment will be due are indicated in the syllabus. Extensions will be granted sparingly and are at the instructor's discretion.

Technical Equipment Needs

The learning experience in this course will mainly rely on the online interaction between the students and the instructors during the weekly online meetings. Therefore, we encourage all students in this course to use a web camera and a headset. Decent quality headsets and web cams are available for less than $20 each. We ask students to refrain from using built-in web cams and speakers on their desktops or laptops. We know from our experience in previous online courses that this will reduce the quality of video and audio transmission and therefore will decrease the overall learning experience for all students in the course. In addition, we suggest that students use a wire connection (LAN), if available, when connecting to the online meetings. Wireless connections (WLAN) are usually less stable and might be dropped.

Mannheim Business School would also like to officially inform you that, in order to facilitate your participation in this course, your personal data will be processed by and on systems run by MBS and our subcontractors. You can find detailed information in our privacy policy and information for data subjects here.

Long Course Description

Perhaps someday we will learn how to ask perfect survey questions that yield perfect answers. Until such times arrive, however, respondents' answers to survey question will typically reflect the opinion or fact we as researchers are after only partly. The other part will be misremembering, differences in interpretation, differences in how arbitrary choices in the answering process are made, mistakes, and so on - in short: measurement error.

Measurement error can seriously disturb analyses of substantive interest. Means, totals, and proportions will be off if the average answer people give is inaccurate. However, measurement error disturbs not just estimates of means but can also severely bias apparent relationships, conditional probabilities, means differences, and other regression-type analyses. To remove such biases it is therefore essential to estimate the extent of measurement error in survey variables.

The most obvious way to estimate the extent of measurement error is to know the true value we are after. For example, survey methodologists often use "gold-standard" data from administrative registers to validate respondents' survey answers. But not all that is administrative data is gold: often such records contain measurement error themselves, or do not fully reflect the concept of actual interest. Moreover, there are many survey variables for which true values are unavailable or impossible to get. Opinions are a good example, but facts such as the party a respondent votes for in elections may also be unknown outside of the survey answer.

This 1-credit/2 ECTS course introduces you to the main alternative solution to measurement error in surveys: statistical modeling. You will be introduced to the three main competencies in this field:

1. **Defining measurement error** conceptually, including the concepts of reliability and validity
2. **Estimating measurement error** in the absence of a gold standard to judge it by, and
3. **Performing regression analyses** from which the influence of measurement error has been removed.

We will have four sessions in which you will watch online lectures, do homework exercises using R, and answer online quizzes.

Readings

Mandatory Readings
Required and recommended readings will be made available on the course website:

Complementary Readings
Interested students might find the following additional recommended books helpful in preparing for the course:

Beaujean, A. (2014). *Latent Variable Modeling Using R: A Step By Step Guide.* New York: Routledge.

Academic Conduct

Clear definitions of the forms of academic misconduct, including cheating and plagiarism, as well as information about disciplinary sanctions for academic misconduct may be found at

https://www.president.umd.edu/sites/president.umd.edu/files/documents/policies/III-100A.pdf (University of Maryland) and

https://www.uni-mannheim.de/en/research/good-research-practice/ (University of Mannheim).

Knowledge of these rules is the responsibility of the student and ignorance of them does not excuse misconduct. The student is expected to be familiar with these guidelines before submitting any written work or taking any exams in this course. Lack of familiarity with these rules in no way constitutes an excuse for acts of misconduct. Charges of plagiarism and other forms of academic misconduct will be dealt with very seriously and may result in oral or written reprimands, a lower or failing grade on the assignment, a lower or failing grade for the course, suspension, and/or, in some cases, expulsion from the university.

Accommodations for Students with Disabilities

In order to receive services, students at the University of Maryland must contact the Accessibility & Disability Service (ADS) office to register in person for services. Please call the office to set up an appointment to register with an ADS counselor. Contact the ADS office at 301.314.7682; https://www.counseling.umd.edu/ads/.

Students at the Mannheim Business School should contact the Commissioner and Counsellor for Disabled Students and Students with Chronic Illnesses at http://www.uni-mannheim.de/studienbueros/english/counselling/disabled_persons_and_persons_with_chronic_illnesses/

Course Evaluation

In an effort to improve the learning experience for students in our online courses, students will be invited to participate in an online course evaluation at the end of the course. Participation is entirely voluntary and highly appreciated.

Please note that assignments and dates are subject to change. Information (e.g., articles and assignments) posted to the course website supersedes the information noted here.

Week 1:

Unit 1: What is measurement error?

Concepts: reliability, validity, common method variance, misclassification, true score

Learning goals:
- Define core concepts above
- Explain the importance of studying reliability, validity, common method variance
- Explain the different kinds of effects each has on subsequent survey research of interest
- Calculate Cronbach's alpha and other reliability measures, criterion validity.

Video lecture (Oberski): available Monday, May 31, 2021

Online meeting (Boeschoten): Monday, June 7, 2021, 12:00 PM EDT/6:00 PM CEST

Online quiz unit 1: due Wednesday, June 9, 2021, 6:00 AM EDT/12:00 PM CEST

Required Readings:
   Alwin, D. (2007). *Margins of Error*. New York: Wiley. Chapters 1-3.

   Saris, W.E. & Gallhofer, I.N. *Design, evaluation, and analysis of questionnaires for survey research*. New York: Wiley. Chapter 9.

Recommended Readings:
   Biemer, P. (2011). *Latent class analysis of survey error.* New York: Wiley. Chapters 1—2.

Week 2:

Unit 2: Estimating measurement error in continuous survey variables

Concepts: test-retest, consistency, multitrait-multimethod, quasi-simplex, structural equation modeling

Learning goals:
- Explain the relative advantages and disadvantages (including assumptions) of test-retest, CFA (consistency), MTMM, and quasi-simplex models
- Run a ready-made script to estimate reliability and other parameters of these models
- Correctly interpret the outcome of these models
- Code a question and obtain a prediction of MTMM results using SQP 2

Video lecture (Oberski): available Monday, June 7, 2021

Online meeting (Boeschoten): Monday, June 14, 2021, 12:00 PM EDT/6:00 PM CEST

Online quiz unit 2: due Wednesday, June 16, 2021, 6:00 AM EDT/12:00 PM CEST

Homework unit 2: due Wednesday, June 16, 2021, 6:00 AM EDT/12:00 PM CEST

Required Readings:
Alwin, D. (2007). *Margins of Error.* New York: Wiley. Chapters 4-6.

Saris, W.E. & Gallhofer, I.N. *Design, evaluation, and analysis of questionnaires for survey research.* New York: Wiley. Chapter 10.

Saris et al. (2011). Final report about the project JRA3 as part of ESS Infrastructure. Chapters 6 & 7.

Survey Quality Predictor (SQP 2.1). Tutorial. URL: http://sqp.upf.edu/

Week 3:

Unit 3: Estimating measurement error in categorical survey variables

Concepts: sensitivity, specificity, hidden markov models (HMM), latent class analysis (LCA)

Learning goals:
- Explain when latent class models are useful for survey error evaluation
- Explain the assumptions inherent in LCA and HMM
- Run scripts that estimate LCA models
- Correctly interpret the results of LCA and HMM models

Video lecture (Oberski): available Monday, June 14, 2021

Online meeting (Boeschoten): Monday, June 21, 2021, 12:00 PM EDT/6:00 PM CEST

Online quiz unit 3: due Wednesday, June 23, 2021, 6:00 AM EDT/12:00 PM CEST

Homework unit 3: due Wednesday, June 23, 2021, 6:00 AM EDT/12:00 PM CEST

Required Readings:
Alwin, D. (2007). *Margins of Error.* New York: Wiley. Chapter 11.

Biemer, P. (2011). *Latent class analysis of survey error.* New York: Wiley. Chapters 4; 6-7.

Kreuter, F., Yan , T. & Tourangeau, R. (2008). Good item or bad – can latent class analysis tell?: the utility of latent class analysis for the evaluation of survey questions. *J. R. Statist. Soc. A, 171 (3).*

Recommended Readings:
Oberski, D. L., Hagenaars, J., & Saris, W. E.. (2016). The latent class multitrait-multimethod model. *Psychological methods.*

Oberski, D. L. (2015). "Estimating error rates in an administrative register and survey questions using a latent class model". Biemer, P., West, B., Eckman, S., Edwards, B., & Tucker, C. (Eds.), In: *Total survey error.* New York: Wiley.

Unit 4: Correcting regression analyses for the effects of measurement error

Concepts: correction for attenuation, errors-in-variables regression, covariance reduction, three-step analysis

Learning goals:
- Explain the effect of measurement error on substantive analyses of interest
- Correct correlations for attenuation
- Estimate an errors-in-variables model using the covariance reduction method
- Explain the principles behind LCA three-step analysis
- Run a three-step analysis and interpret the results

Video lecture (Oberski): available Monday, June 21, 2021

Online meeting (Boeschoten): Monday, June 28, 2021, 12:00 PM EDT/6:00 PM CEST

Homework unit 4: due Wednesday, June 30, 2021, 6:00 AM EDT/12:00 PM CEST

Required Readings:
Bakk, Tekle & Vermunt (2013). Estimating the Association between Latent Class Membership and External Variables Using Bias-adjusted Three-step Approaches. *Sociological Methodology*, 43, p. 272.

Castellarnau, A. & Saris, W.E. (2015). A simple procedure to correct for measurement errors in survey research. URL: http://essedunet.nsd.uib.no/cms/topics/measurement/

Saris, W.E. & Gallhofer, I.N. *Design, evaluation, and analysis of questionnaires for survey research.* New York: Wiley. Chapter 15.

Muthén & Asparouhov. Three step webnote.

Recommended Readings:
Vermunt, Jeroen K. (2010). Latent Class Modeling with Covariates: Two Improved Three- Step Approaches. *Political Analysis* 18:450–469.

Optional further reading:
Fuller, W.A. (1987). *Measurement error models.* New York: Wiley.

Carroll, Ruppert & Stefanski. *Nonlinear measurement error models.* CRC press.

Final exam: due Friday, July 9, 2021, 6:00 AM EDT/12:00 PM CEST

	Unit 1	**Unit 2**	**Unit 3**	**Unit 4**
Video available	Monday, May 31, 2021	Monday, June 7, 2021	Monday, June 14, 2021	Monday, June 21, 2021
Online meeting	Monday, June 7, 2021, 12:00 PM (EDT)/ 6:00 PM (CEST)	Monday, June 14, 2021, 12:00 PM (EDT)/ 6:00 PM (CEST)	Monday, June 21, 2021, 12:00 PM (EDT)/ 6:00 PM (CEST)	Monday, June 28, 2021, 12:00 PM (EDT)/ 6:00 PM (CEST)
Online quiz due	Wednesday, June 9, 2021, 6:00 AM (EDT)/ 12:00 PM (CEST)	Wednesday, June 16, 2021, 6:00 AM (EDT)/ 12:00 PM (CEST)	Wednesday, June 23, 2021, 6:00 AM (EDT)/ 12:00 PM (CEST)	*No quiz for unit 4*
Homework due	*No homework for unit 1*	Wednesday, June 16, 2021, 6:00 AM (EDT)/ 12:00 PM (CEST)	Wednesday, June 23, 2021, 6:00 AM (EDT)/ 12:00 PM (CEST)	Wednesday, July 2, 2021, 6:00 AM (EDT)/ 12:00 PM (CEST)
Final exam due				Friday, July 9, 2021, 6:00 AM (EDT)/ 12:00 PM (CEST)