Measurement Error Models
SURV730
1 credit/2 ECTS
Spring 2019, section 1

Instructor
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Video lectures by Daniel Oberski

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 and Learning 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 and then “attending” 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 videos, participating in online meetings), and follow-up activities (working on assignments and exams) – as in an on-site course. As a rule of thumb, for each credit offered by a course, students can expect to spend one hour per week on in-class activities and three hours per week on out-of-class activities over the span of a full 12-week term. This is a 1-credit course that runs for 4 weeks. Hence, the total average workload is about 12 hours per week.

Mandatory Weekly Online Meetings

*Wednesday, 11:00 AM EST/5:00 PM CET, starting March 6*

Meetings will be held online through Zoom. Follow the link to the meeting sessions on the course website on [https://www.elms.umd.edu/](https://www.elms.umd.edu/). If video participation via Internet is not possible, arrangements can be made for students to dial in and join the meetings via telephone.

*Keep in mind that daylight saving time begins in the US on March 10, 2019 and clocks are turned forward 1 hour. Daylight saving time begins in Europe on March 31, 2019. Therefore, the exact meeting and deadline times are sometimes different.*

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 weekly forum on the course page before the meetings (deadline for sending questions via e-mail is usually 24 hour prior to the weekly online meetings (Tuesday, 12:00 PM EDT/5:00 PM CET)).

Students have the opportunity to use the Zoom meeting room set up for this course to connect with peers outside the scheduled weekly online meetings (e.g., for study groups). Students are encouraged to post the times that they will be using the
room to the course website forum to avoid scheduling conflicts. Students are not required to use Zoom and can of course use other online meeting platforms such as Google Hangout or Skype.

**Grading**

Grading will be based on:
- 3 online quizzes (worth 30% total, 10% each)
- Participation in discussion during the weekly online meetings and submission of questions to the weekly forum demonstrating understanding of the required readings and video lectures (10% of grade)
- A final open-book online exam (60% 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.

**Technical Equipment Needs**

The learning experience in this course will mainly rely on the online interaction between students and the instructor 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.

**Overview of the Course**

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 and answer online quizzes including R applications.

**Readings**

Required and recommended readings will be made available on the course website: [https://www.elms.umd.edu/](https://www.elms.umd.edu/)

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


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


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 Disability Support Services (DSS) office to register in person for services. Please call the office to set up an appointment to register with a DSS counselor. Contact the DSS office at 301.314.7682; http://www.counseling.umd.edu/DSS/.

Students at the University of Mannheim 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 (in addition to the standard university evaluation survey). Participation is entirely voluntary and highly appreciated.
Class Schedule

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.

Daylight saving time begins in the US on March 10, 2019 and clocks are turned forward 1 hour. Daylight saving time begins in Europe on March 31, 2019. Therefore, look carefully at the times of meetings and deadlines!

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: available Wednesday, February 27, 2019

Online meeting: Wednesday, March 6, 2019, 11:00 AM EDT/5:00 PM CET

Readings:


Recommended:

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

Video lecture: available Wednesday, March 6, 2019

Online quiz 1: due Tuesday, March 12, 2019, **12:00 PM EDT/5:00 PM CET**

Online meeting: Wednesday, March 13, 2019, **12:00 PM EDT/5:00 PM CET**

Readings:


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

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

**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: available Wednesday, March 13, 2019

Online quiz 2: due Tuesday, March 19, 2019, **12:00 PM EDT/5:00 PM CET**

Online meeting: Wednesday, March 20, 2019, **12:00 PM EDT/5:00 PM CET**

Readings:


Recommended:


**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:** available Wednesday, March 20, 2019

**Online quiz 3:** due Tuesday, March 26, 2019, **12:00 PM EDT/5:00 PM CET**

**Online meeting:** Wednesday, March 27, 2019, **12:00 PM EDT/5:00 PM CET**

**Readings:**


- Muthén & Asparouhov. Three step webnote.

**Recommended:**

Optional further reading:


**Final Online Exam**
Due: Friday, April 5, 2019, 11:00 AM EDT/5:00 PM CEST

**Note:** Student access to the course website will be revoked two weeks after the final exam.