Федеральное государственное автономное образовательное учреждение высшего образования
"Национальный исследовательский университет
"Высшая школа экономики"

Санкт-Петербургская школа социальных и гуманитарных наук
Департамент социологии

Рабочая программа дисциплины

Основы моделирования структурными уравнениями/
Introduction to Structural Equation Modeling
(читается на английском языке)

для направления 39.04.01 Социология
магистерской программы
«Сравнительные социальные исследования» / Comparative Social Research

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Утверждена Академическим советом образовательной программы
«Сравнительные социальные исследования»
«___»_____ 201_ г., № протокола_____

Академический руководитель образовательной программы
Фрёлих, Кристиан _____

Санкт-Петербург, 2018

1 Scope of Use

This syllabus outlines minimum requirements, objectives, learning outcomes, and content of the course.

The syllabus is designed for the instructors teaching this discipline, their teaching assistants, and the students of the Master Program 39.04.01 “Sociology” who have taken the course “Introduction to Structural Equation Modeling (taught in English).”

The syllabus complies with the following documents:

- The Educational Standard of the National Research University “Higher School of Economics” for the master program 39.04.01 “Comparative Social Research”;
- The Educational Program “Sociology” for the master program 39.04.01 “Comparative Social Research”;
- The University Curriculum of the National Research University “Higher School of Economics” for the 1st–year students of the master program 39.04.01 “Comparative Social Research”

2 Learning Objectives

The course is intended to give an introduction to the foundational concepts and basic computational techniques of structural equation modeling (SEM) and their implementation in a popular SEM software tool, R package *lavaan*. The topics covered by the course are confirmatory factor analysis (CFA), measurement invariance, path models, and structural equation models. In addition, practical issues of estimation (including Bayesian estimation), visualization and presentation of various types of SEM models are discussed.

Students are assumed to have basic knowledge of statistics and be familiar with several conventional statistical methods, most importantly regression analysis. In addition, for practical exercises we will use R programming environment, so a basic knowledge of R is desirable. However, it is not a necessary prerequisite, and a short introduction to R will be given in the beginning of the course.

3 Intended Learning Outcomes

As a result of this course, students will be able to:

- Understand foundational concepts of confirmatory factor analysis (CFA) and structural equation modeling (SEM);
- Understand basic assumptions of CFA and SEM models;

- Understand and apply in practice basic principles of model building, model evaluation and model modification in CFA and SEM
- Build, estimate, assess, compare and modify confirmatory factor an/or structural models using R packages *lavaan* and *semTools*;
- Visualize various types of measurement and structural models using R package *semPlot*;
- Understand the concept of measurement invariance and apply different approaches to measurement invariance testing.
- Conduct multigroup confirmatory factor analysis (MGCFA) and test for measurement invariance using R packages *lavaan* and *semTools*;
- Apply different approaches to theory testing in SEM;
- Understand the concepts of moderation and mediation in SEM;
- Conduct mediation analysis in *lavaan*
- Understand basic concepts of Bayesian estimation and how to apply it in the structural equations context
- Perform Bayesian CFA and SEM using R package *blavaan*

The course develops the following competencies:

Competence	NC/NRU HSE Code	Descriptors (learning outcomes and indicators of achievement)	Forms and methods of teaching contributing to the development of a competence
Students should develop the following systemic competencies:			
Ability to reflect on learned SEM concepts and methods	СК-М1	Student processes learned information, and is capable of integrating learned material into a cohesive research toolchest	Lectures, readings, home assignments, data analysis projects
Ability to work with complex data and use SEM methods appropriately.	СК-М2	Student is able to select appropriate SEM method for a given data analysis problem	Lectures, readings, in-class exercises, home assignments, data analysis projects
Ability to develop continually own intellectual potential and critical reasoning skills and plan further professional career appropriately.	СК-М4	Student is able to define relevant research question for his/her own research and to evaluate appropriately research projects of other	Readings, data analysis projects

		students/scholars, including those published in top-level social sciences journals. Student demonstrates a well-developed ability to learn advanced SEM methods and apply them in practice correctly without the instructor’s assistance.	
Ability to conduct own research independently and translate conceptual thinking into publication-quality papers	СК-М6	Student confidently uses available data to test proposed hypotheses, is able to develop a solid theoretical foundation for the project at hand and to integrate information found from various sources and compensate for lack of data by adjusting models.	Lectures, readings, in-class exercises, home assignments, data analysis projects
Students should demonstrate the following instrumental competences:			
Ability to use advanced sociological methods for scientific research and policy analysis.	ПК-2	Student is able to apply learned SEM methods both to scientific and applied problems	Lectures, readings, in-class exercises, home assignments, data analysis projects
Ability to direct a scientific research project	ПК-3	Student is able to formulate key research objectives and research questions, select an appropriate design (including analytic framework and methods to use), interpret results and prepare report on results, as well as to direct the work of subordinate collaborators.	Home assignments, data analysis projects
Ability to conduct written and oral communication in English to convey research ideas	ПК-7	Concisely and precisely expresses research ideas in English in written and oral communication	Lectures, readings, inclass exercises, home assignments, data analysis projects
Ability to work in multicultural environment	ПК-15	Student is able to work in multi-cultural groups to	Lectures, in-class exercises, home

		fulfill their class assignments and should cooperate with international classmates in the learning process.	assignments
Ability to generate new ideas and solutions for scientific and applied problems	ПК-21	Student is able to offer effective solutions for both typical and issue-specific problems arising in applied social science research.	In-class exercises, home assignments, data analysis projects

4 Target Audience and Prerequisites.

This course is a compulsory course for students of the master program 39.04.01 “Comparative Social Research”. Taking this course requires the successful prior completion of the following disciplines:

- Basic Statistics and Introduction into „R“
- Methodology and Research methods in Sociology: Quantitative Research methods

To succeed in this course, students are expected to possess the following knowledge and competences:

- The ability to develop new concepts and models and apply them in professional work (GC-M2);
- The ability to work with information and existing literature (PC-11/IC-M4);
- The ability to speak a foreign (English) language at a level sufficient for informal communication as well as for the search and analysis of foreign sources of information (PC-8/IC-M2).

The course is strongly related and complementary to other compulsory courses and provides crucial prerequisites for later courses and research projects as well as skills necessary for the master thesis. The course takes place in the fourth module of the first year of the program, giving students the important skills in designing and conducting their own research as well as assessing the quality of research projects published in a series of working papers and peer-reviewed social science journals.

5 Course Content and Structure

This course is worth 4 credit units.

No.	Topic	Total	Classroom Hours	Individual

		Academic Hours	Lectures	Practice sessions	(library/lab) work
1	Introduction. Basic Concepts of Latent Variable Modeling. Confirmatory Factor Analysis	19	2	2	15
2	CFA Model Estimation, Assessment and Visualization	19	2	2	15
3	Advanced CFA models	19	2	2	15
4	Multi-Group CFA and Measurement Invariance	19	2	2	15
5	Testing Measurement Invariance in Categorical Data	19	2	2	15
6	Full Structural Models	19	2	2	15
7	Moderation and Mediation in SEM	19	2	2	15
8	Bayesian SEM	19	2	2	15
	Total:	152	16	16	120

6 Indicative Assessment Methods

Type of Control	Form of Control	Detailed explanation
Weekly	Home assignments	Students are expected to complete written home assignments outside of class time. Some assignments are conceptual, but most require using R and empirical data (these assignments will typically be related to a student’s research project for this course; see below), therefore students should plan to spend time in the computer lab outside of regular class hours. All out-of-class assignments are due at the beginning of the class time on the assigned day.
	Class work	Students are expected to participate in all class activities, such as group discussions, responses to the instructor’s questions, and completion of simple conceptual and programming exercises.
	Progress reports	Students are expected to write a short research paper (see below). Through the course they will be given several opportunities to present their progress. Preparing progress reports and sending them to the instructor is mandatory though presenting your work in class is a voluntary option. Notice, however that frequent presentations may improve your personal cumulative grade (conditional on their overall quality, they will contribute to the grade for class work) as well as help a lot in the preparation of the final paper.

Final	Exam	In lieu of a final exam, this course requires students to write a short empirical research paper (10-15 pages) in which they will try to apply structural equation modeling methods to the topic in cross-cultural social research that they are interested in. This paper must follow the model of English-language published scientific journal articles. The most important aspects of the paper to be graded are the creativity of the research idea, the operationalization and proper statement of hypotheses, and the appropriate use of Bayesian statistics. Final versions should be submitted not later than noon of June 10th, 2018. All papers will be assessed by the instructor and preliminary grades will be announced (not later than one week after the submission deadline). Those course participants who disagree with their preliminary grade will be given an opportunity to defend their research paper (by publicly presenting it in class). Presentations must be given using MS PowerPoint or LaTeX software. See detailed info about general final paper requirements below, in Section 11 of this syllabus.

7 Assessment criteria

7.1 Class work:

You may expect an excellent grade (8-10 on a 0-10 scale) for class work if you actively participate in in-class discussions and other activities, frequently present your homework and progress reports, and demonstrate a good performance when responding to the instructor’s conceptual questions and performing simple in-class programming exercises. The general rule is the lower your activity the lower your grade, though it is worth noting that the overall quality of your in-class performance also matters in this respect. If you make mistakes regularly when responding to my questions, performing exercises, or presenting your own work, it will negatively affect your grade.

Please notice that attendance is not obligatory, so you can safely miss a few classes (e.g. one or two, especially lectures). However, if you miss all classes, your grade for class work will be zero. Also keep in mind that if you miss class you are still responsible for everything covered in class, including announcements. Similarly, being absent does not excuse you from obtaining handouts and assignments that you may have missed. It is your responsibility to find out what you have missed and to make arrangements to obtain any handouts, assignments, etc

7.2 Homework assignments;

Most your written home assignments will be related to preparation of your final paper (see the complete list of last year’s home assignments below, in Section 10.1 of this syllabus).

The most important aspects of home assignments to be graded are: (a) ability to formulate an original research question which at the same time is related to ongoing theoretical debates (0-2 points); (b) ability to operationalize your theoretical/conceptual model using relevant data (0-2 points); (c) appropriate use of SEM methods (0-2 points) and (d) specific SEM terminology (0-1 points), as well as (e) the ability to interpret the results of your analyses correctly (0-2 points).

Notice that (f) style and formatting issues (e.g. correct formatting of tables, figures, in-text citations, and references) also affect the final grade (0-1 points). I do not expect that your style and grammar will be perfect, but I should be able, at least, to understand from the text of your assignment what exactly you have done,

Also notice that late assignments will be graded down (by 1 grading point on a 0-10 scale per day of delay; assignments submitted with a delay of three days or more will be penalized by 3 points irrespective of the length of delay).

7.3 Progress reports

Similar to home assignments

7.4 Final paper

See detailed info below, in Section 11.5 of this syllabus.

8 Course Outline

Lesson 1: Introduction

(15:10, Tuesday, April 3th, room 429, 11 Myasnitskaya str.)

Course overview. The concept of latent variable. The concept of construct. Formal definition of CFA (confirmatory factor analysis) model: assumptions, key model parameters, notation. Differences between CFA and EFA (exploratory factor analysis).
Recommended Reading:
Bollen 2002; Brown 2006, Chapters I-II, Chapter III, pp. 40-59;

Lesson 2: CFA Model Estimation, Assessment and Visualization

(16:40, Tuesday, April 3th, room 429, 11 Myasnitskaya str.)

Model identification. Not identified, just identified and over identified CFA models. Various types of parameter constraints used for model identification. Model fit. Various goodness-of-fit measures (Chi-Square, RMSEA, CFI, etc.): their relative advantages and drawbacks. Model building in

lavaan. Estimation of CFA models using R package *lavaan*. Interpretation of model parameters. Visualization of CFA models in *semPlot*

Recommended Reading:

Brown 2006, Chapters III-IV; Hu and Bentler 1999, Chen et al. 2008; Rosseel 2012; Epskamp 2015

Lesson 3: Advanced CFA models

(15:10, Wednesday, April 4th, room 320a, 11 Myasnitskaya str.)

Model modification and models comparison (chi-square difference test). Models with mean structure. CFA models for categorical data. Second-Order CFA models. Missing data issues.

Recommended Reading:

Brown 2006, Chapter V; Saris, Satorra & van der Veld 2009; Anderson and Gerbing 1988; Satorra and Bentler 2010

Lesson 4: Multi-Group CFA and Measurement Invariance

(16:40, Wednesday, April 4th, room 320a, 11 Myasnitskaya str.)

Multi-group CFA (MGCFA). The concept of measurement invariance (equivalence). Types of invariance: configural, metric and scalar. How to proceed with invariance testing in *lavaan*. Invariance testing for measurement models defined on categorical indicators. Using *semTools* for automated invariance testing in R. EPC-interest.

Recommended Readings:

Brown 2006, Chapter VII; Chen 2007; Davidov et al. 2011; Davidov et al. 2014; Oberski 2014

Lesson 5: Testing Measurement Invariance in Categorical Data

(15:10, Tuesday, May 15th, room 320, 11 Myasnitskaya str.)

Multi-group categorical CFA (MGCCFA). Required parameter constraints for model identification in MGCCFA. Delta vs. Theta parameterization. Invariance testing for categorical data in *lavaan*. What to do when there is no invariance? EPC-interest

Recommended Readings:

Millsap and Tein 2004; Alemán and Woods 2016; Welzel and Inglehart 2016; Asparouhov and Muthen 2014; Meuleman et al. 2012; van de Shoot et al. 2013; Oberski 2014

Lesson 6: Full Structural Models (May 25th)

(16:40, Tuesday, May 15th, room 320, 11 Myasnitskaya str.)

The basic concepts of SEM. Exogenous and endogenous variables. Path models. SEM with latent variables and multiple indicators. Causality and equivalent models. Typology of model testing. Example of a path model. Example of a simple SEM with endogenous latent variable and observed exogenous variables.

Recommended Readings:

Byrne 2012, Chapter I; Anderson and Gerbing 1988; Boomsma 2000

Lesson 7: Moderation and Mediation in SEM

(15:10, Wednesday, May 16th, room 324, 11 Myasnitskaya str.)

Moderation and mediation. Indirect and total effects and their computation in *lavaan*. Models with more than one latent variable. Latent interactions.

Recommended Readings:

Baron and Kenny 1986; Zhao, Lynch, and Chen 2010; Muller, Judd, and Yzerbyt 2005; Little et al 2007.

Lesson 8: Bayesian Structural Equation Modeling

(16:40, Wednesday, May 16th, room 324, 11 Myasnitskaya str.)

Bayes’s rule. Prior distributions: informative and non-informative. Monte-Carlo Markov Chain estimation. MCMC diagnostics. Posterior inference: point estimate and credibility interval. Bayesian CFA and SEM models. *blavaan* package.

Recommended Readings:

Muthén Asparouhov 2012; Quinn 2004; Western 1999; .

9 Educational Techniques

The goal of this course above and beyond teaching specific methods is to enable students to use the methods covered in the course on a stand-alone basis whenever they need this in the future. Therefore, every reasonable effort should be made to make the material understandable and comprehensible, depending on the level of the student.

It is also crucially important to encourage those students who have already understood new material to share their understanding with the others has demonstrated rewarding results.

Regular Q&A sessions are needed at the end of each session, both on lectures and on practical exercises.

The general recommendation is to put emphasis on training the skills to perform the same types of analysis autonomously; therefore, the more time students get to practice their data analysis skills on different data sets, the more reliable the success of the course.

9.1 Recommendations to the Instructor

Try using as many ways of approaching students as possible. Since the knowledge and readiness to learn in English is non-equal among students, be always prepared to stratify exercises as well as theory for different levels. Find and use the youtube.com tutorials on R and lavaan. Small groups are always encouraged whenever possible and reasonable.

9.2 Recommendations to the Students

The key goal of this course is to equip you with a toolkit of state-of-the-art methods of statistical analysis especially relevant for the purposes of comparative social research. You are offered an array of methods of data analysis which you are likely to use while staying in the social sciences and beyond.

To learn these methods successfully, do not hesitate to pose your questions to the instructor. Additionally, try keeping a vocabulary on each topic covered, with the most important terms explained with examples (in this respect, you may find a list of self-check questions, offered below in Section 10.2, helpful). This will help you at the exam and in the future as your personal reference book. In your free time, read and watch as much about the topic as possible. Having read the same

topic from several textbooks and also websites (including SEM-related Wikipedia articles!) as a rule improves your understanding substantially.

Watch and learn extra beyond the classes. Look through the pages of the recent issues of such journals as the Structural Equation Modelling, Journal of Cross-Cultural Psychology, Frontiers in Psychology, European Sociological Review, Psychometrika, Sociological Methods and Research, Survey Research and Methods, etc., to learn how to report the results of SEM. Complete online SEM courses on Coursera.org or any other online learning platform to recap on basic SEM concepts and methods if you feel you could benefit from it.

Do not wait until the end of the course to see me regarding problems with course materials or your performance (it will be too late to address deficiencies at the end of the semester). If you are aware that you must achieve a particular grade in this course, please see me during the first week of the course. This will allow me to alert you of deficiencies in your performance. There is nothing that either of us can do at the end of the course

10 Home Assignments and Self-Check Questions

10.1 Empirical home assignments (also can be seen as a step-by-step guidance for preparation of the final paper).

1. Choose a large cross-national survey dataset (e.g., World Values Survey, European Social Survey, European Values Study, Eurobarometer, etc.). Choose any two or three (no more than three!) countries covered within the same round of your preferred survey. Choose a theory close to your research interests; derive one or several constructs from it, which can be measured using data from your preferred survey. Define measurement model for your construct (-s): choose relevant survey items that may serve as its indicators. Think about the construct’s potential correlates (variables that can affect it, or be affected by it, in a causal manner).
2. Estimate your measurement model. How well does it fit your data? Do some problematic parameters present in your model? Plot your measurement model using semPlot package. Prepare written description of your analysis and its results (with carefully created tables and path diagrams; Table 4.6 in Brown 2006 may be helpful). Provide replication code.
3. Does your measurement model presented at the last class fit well? If not, try to find a better specification for your model. Describe your additional analysis and its results (with carefully prepared tables and path diagrams) in a written form. Provide replication code.
4. Try to establish full, or at least partial, measurement invariance for your model across chosen countries. Describe your analysis in a written form. Provide replication code.

5. Derive several hypotheses from your preferred theory (two to four), involving your latent constructs defined and measured in previous assignments as either a cause or consequence of variation in some other variables (either latent or directly observed). Define a structural model according to your hypotheses (do not forget to include measurement models for the relevant constructs in the structural model as its particular components). Estimate your models in lavaan; report the results (including path diagrams) in a written form.
6. Try to check for mediation effects in your structural model.
7. Try to re-estimate some of your models from Steps 2 to 6 using Bayesian methodology.

To succeed with home assignments (and with the final paper as well) put a considerable effort in choosing a theory which is well elaborated in the sociological literature and at the same time close to your own research interest and deriving a conceptual model from that theory, which can be tested using SEM methods. Then select carefully a data set from any large-N cross-national survey project (e.g. European Social Survey, World Values Survey, Eurobarometer, etc.) that allows you to test properly your conceptual model. Notice that you may replicate results that have been reported in the literature, but in such case you should use other data than those used in the original paper. Complex models are encouraged. However, even simple models, if correctly specified, tested and interpreted, will earn you a good grade. Each time remember to submit your R syntax an appendix and provide correct references to the data set, as well as a proper description of analytical procedures and an interpretation of the results in the main text of the assignment paper. Be ready to present and defend your work in class.

10.2 Self-check questions.

1) What is latent variable? What is construct?

2) Common factor model: Notation, key concepts, such as factor loading, communality, uniqueness, eigenvalue and factor score.

3) Confirmatory factor analysis (CFA). Differences between CFA and exploratory factor analysis.

4) Key parameters in CFA: factor loadings, residual variances, factor variances/covariances

5) Model identification. Not identified, just identified and over identified CFA models.

6) Various types of parameter constraints used for model identification in CFA.

7) Popular goodness-of-fit measures (Chi-Square, RMSEA, CFI, SRMR/WRMR); their relative advantages and drawbacks.

8) Model modification and model comparison (chi-square difference test; AIC/BIC).

9) Models with mean structure. The concept of intercept.

10) CFA models for categorical data. Thresholds. Scaled Chi-square difference test.

11) Second-Order CFA models.

12) Missing data issues: MCAR, MAR and NMAR. Listwise and pairwise deletion, FIML.

13) Multi-group CFA (MGCFA): model identification.

14) Measurement invariance (equivalence). Types of invariance: configural, metric and scalar.

15) Fit criteria for assessing measurement invariance.

16) MGCFA with categorical data: parameter constraints required to obtain identification.

17) MGCFA with categorical data: delta vs. theta parameterization.

18) Basic concepts of SEM: exogenous and endogenous variables; path models, MIMIC models.

19) Causality and equivalent models. Typology of model testing.

20) Moderation and mediation. Indirect and total effects in SEM.

21) Causal mediation in SEM. Applying DAGs in the structural equation modeling contexts.

22) Bayes’ rule. What are prior distributions, likelihood, and posterior distribution?

23) Key quantities used to summarize posterior inference in Bayesian analysis: point estimate (posterior mode/mean) and credibility intervals.

24) MCMC estimation; Gibbs sampling; key MCMC convergence diagnostics

25) Bayesian model comparisons: DIC, cross-validation, and Bayes factors.

11 Final Paper Requirements

Note: (This list of recommendations has been built upon a framework developed by A. Almakaeva, M. Tawat, and S. Spencer: see Section 12 of this file: https://www.hse.ru/data/2017/04/27/1168759732/program-1711306534-5jHlOiLKAq.pdf).

All course participants must write a short research paper (15-20 pages) in which they will try to apply structural equation modeling methods to the topic in cross-cultural social research that they are interested in. The most important aspects of the paper to be graded are the creativity of the research idea, the operationalization and proper statement of hypotheses, and the appropriate use of SEM methods. Final project paper must be written alone, independent of other student projects.

11.1 Format

MS Word or LaTeX, 10-15 pages long, typed, double-spaced, standard margins. Notice that page count does not include abstract, references, and appendices, as well as figures and tables.

11.2 Purpose

This paper is an academic research paper presenting the results of your secondary data analysis. This paper should demonstrate your 1) logical reasoning, 2) your skill at interpreting the results of

structural equation modeling, and 3) your ability to communicate in academic writing style.

11.3 Content

This paper, like all academic research papers, must contain the following sections:

1. Abstract
2. Introduction
3. Literature review
4. Data and Methods
5. Findings
6. Discussion/conclusion
7. References.
8. *Appendix (-ces) (If necessary)*

ABSTRACT: A one-paragraph summary of the research question and (only) main findings (on a separate page, not counted in the page count).

INTRODUCTION: In this section you formulate the research question and establish its scientific relevance (i.e. explain “why it is important to study this topic”, may also include social or policy relevance).

LITERATURE REVIEW: This section examines your research question in terms of the theory that generated it, and reviews existing sociological research addressing the question, including research that may be only partially related. If your specific topic appears to be understudied, this section should address what is available on related topics. The literature review generally includes a mention of how the current research replicates previous research, contradicts previous research, or somehow modifies or extends previous research. At the end of this section, you must clearly state the hypothesis or hypotheses to be tested in subsequent empirical analysis. It should be obvious how the hypotheses are related to the theoretical background outlined in the literature review.

For the length of this paper, your literature review must make reference to at least ten (10) recent academic peer-reviewed journal articles on your topic.

DATA & METHODS: This section briefly describes the dataset and analytical methods that you use. This section should (a) explain how the research question is operationalized into testable

hypotheses; (b) clearly state the concepts to be tested in the hypotheses, as well as label the independent variables, the dependent variable, and any intervening or control variables that are included; (c) describe which variables are measuring which concepts and from which sources data on these variables come; and (d) identify which statistical methods are used to analyze data. Notice that the list (table) of descriptive statistics on all variables has to be reported in the Appendix.

FINDINGS: This is the section in which you present your findings and explain the results of your statistical tests. Name the test or procedure used to obtain each result (i.e., whether it is an outcome of a linear regression model or some other method). This section should also address whether the analysis of data confirms your hypotheses.

DISCUSSION/CONCLUSION: This section should *briefly* summarize the findings. It should also explain how your findings contribute to the literature reviewed at the beginning of the paper. Discuss whether your findings support or contradict previous research. This section should also briefly discuss limitations of your empirical analysis (especially methodological and data-related ones): for instance, evaluate whether [some of] your concepts could have been measured differently or different tests could be run to answer your substantive research questions. This section may include suggestions for future research or implications for policy or both, but offering future research or policy implications is not a mandatory task.

REFERENCES: All references cited in the text must be listed in the bibliography according to either ASA format, or APA format, or Chicago Manual of Style. You paper should refer to at least 10 peer-reviewed articles published in the top social sciences journals but may also refer to additional sources, such as prominent sociological books, electronic resources, data sets, contributions to edited volumes, etc. For all in-text citations use the author-date format, e.g. (Welzel 2013) or (Inglehart, Ponarin, and Inglehart 2017).

APPENDIX: This section contains all tables and figures referenced in the main text, as well as describe (if necessary) all additional tests and procedures conducted to check the robustness of your main findings under different model assumptions. Notice that replication data (i.e. your data set, as well as an R script used to produce all figures, tables and other results reported in the main text and the appendix) are also worth to be submitted along with the final paper.

11.4 Style and presentation

Prepare tables and figures carefully. Look through the pages of the recent issues of such journals as

Structural Equation Modelling, *Journal of Cross-Cultural Psychology*, *Frontiers in Psychology*, etc., to learn how to report the results of SEM analysis. Remember to include replication code in an appendix. The paper should be accompanied by a Power Point (or equivalent, preferably LaTeX) presentation of the paper. At the **defense**, you will be asked to publicly present the design and the key results of your research. You will have about 10 minutes to tell the audience about your research (in English). You will get a higher grade if you are able to successfully demonstrate (a) a deep understanding of the method, (b) proficient skills in using SEM methods to analyze real data and ability to interpret the results of SEM analysis correctly, as well as (c) good presentation skills.

11.5 Grading Criteria

As it is indicated above, the most important aspects of the paper to be graded are the creativity of the research idea (0-2 points), the operationalization and proper statement of hypotheses (0-4 points), and the appropriate use and interpretation of structural equation modeling methods (0-4 points). However, style and formatting issues may also affect the final grade. Final project paper must be written alone, independent of other student projects. If you plagiarize, you will fail. The deadline for submitting final papers is noon of June 10th, 2018. Late submissions will be graded down (one point on a 1-10 scale per day of delay; papers submitted with a delay of three days or more will be penalized by 3 points, irrespective of the length of delay)

12 Final Grade Components

Your final grade is composed of four components: (a) home assignments (unweighted average), (b) class work, (c) progress reports (unweighted average), and (d) final project. The first three components (taken with different weights) define your accumulated grade (which comprises 65% of the overall grade) which is then combined with the score for the final paper (35% of the overall grade).

Formally, your cumulative grade for the course is calculated in the following way:

$$\mathbf{G_{cumulative} = 0.5 * G_{home\ assignment} + 0.1 * G_{class\ work} + 0.4 * G_{progress\ reports}} \quad \mathbf{(1)}$$

where $G_{home\ assignment}$ is the mean [unweighted] grade for home assignments prepared throughout the course; $G_{class\ assignment}$ is the [single, *post hoc*, on a 1-10 scale] assessment of your overall participation in class activities; and $G_{progress\ reports}$ is the mean [unweighted] grade for final paper progress reports.

The final (overall) grade for the course (the one you will have in your course records) is calculated

in the following way:

$$G_{final} = 0{,}65 * G_{cumulative} + 0.35 * G_{final\ paper} \quad (2)$$

where $G_{cumulative}$ is the accumulated grade for the course calculated using the formula above and $G_{final\ paper}$ is the grade for the final research paper.

Both the cumulative grade and the final grade are rounded according to the rules of algebra

All late submissions (both home assignments, progress reports, and the final paper) will be graded down (the maximum grade for a one-day delay is 7 points; this quantity decreases by one point per extra day of delay; all works submitted with a delay of three and more days are evaluated on a 0-4 scale). If you plagiarize, you will fail. However, it is fine to combine your final research project with other class papers (e.g., term paper).

The minimal passing grade for this course is 4.

Re-examination policy: Students who fail the course are entitled to retake a final exam (precisely speaking, they will have to present and defend an updated and improved version of their final paper). This reexamination option will count only toward the students’ final paper grade (35% of the overall grade for this course). Students’ reexamination grade will not substitute for poor grades earned prior to the final exam in other aspects of the course (home assignments or class work). Therefore, students seeking a minimally passing grade must also turn in home assignments, activity in class, and the paper.

13 Recommended Readings

13.1 Recommended textbook

- Brown, Timothy. 2015. *Confirmatory factor Analysis for Applied Research*. London, UK: Guilford Press

13.2 Key Methodological References

- Alemán, J., & Woods, D. (2016). Value Orientations from the World Values Survey: How Comparable Are They Cross-Nationally? *Comparative Political Studies*, 49(8), 1039-1067.
- Anderson, J. C., & Gerbing, D. W. (1988). Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach. *Psychological Bulletin*, 103(3), 411-423.
- Baron, R. M., & Kenny, D. A. (1986). The Moderator–Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations.

Journal of Personality and Social Psychology, 51(6), 1173-82.

- Bollen, K. A. (2002). Latent Variables in Psychology and the Social Sciences. *Annual Review of Psychology*, 53, 605-634.
- Boomsma, A. (2000). Reporting Analyses of Covariance Structures. *Structural Equation Modeling*, 7(3), 461-483.
- Brown, T.A. (2006) Confirmatory factor Analysis for Applied Research. London, UK: The Guilford Press.
- Byrne, B.M. (2012). *Structural Equation Modeling with Mplus. Basic Concepts, Applications and Programming*. New York, NY; Hove, UK: Routledge.
- Chen, F. F. (2007). Sensitivity of Goodness of Fit Indexes to Lack of Measurement Invariance. *Structural Equation Modeling* 14(3), 464-504.
- Chen, F., Curran, P. J., Bollen, K. A., Kirby, J., & Paxton, P. (2008). An Empirical Evaluation of the Use of Fixed Cutoff Points in RMSEA Test Statistic in Structural Equation Models. *Sociological Methods & Research*, 36(4), 462-494.
- Davidov, E. (2009). Measurement equivalence of nationalism and constructive patriotism in the ISSP: 34 countries in a comparative perspective. *Political Analysis*, 17(1), 64-82.
- Davidov, E. & Datler, G. & Schmidt, P & Schwartz S. H. (2011) Testing the Invariance of Values in the Benelux countries with the European Social Survey: Accounting for Ordinality. In: E. Davidov, P. Schmidt & J. Billiet (Eds.), Cross-*Cultural Analysis: Methods and Applications* (European Association of Methodology) (pp. 149-168). New York, NY; Hove, UK: Routledge
- Davidov, E., Meuleman, B., Cieciuch, J., Schmidt, P., & Billiet, J. (2014). Measurement Equivalence in Cross-National Research. *Annual Review of Sociology*, 40, 55-75.
- Kline, R. B. (2015). Principles and practice of structural equation modeling. London, UK: The Guilford Press.
- Little, T. D., Card, N. A., Bovaird, J. A., Preacher, K. J., & Crandall, C. S. (2007). Structural Equation Modeling of Mediation and Moderation with Contextual Factors. In Little, T. D., Bovaird, J. A., & N.A. Card (Eds.), *Modeling Contextual Effects in Longitudinal Studies* (pp. 207-230). New York, NY; London, UK: Psychology Press.
- Meuleman, B. (2012). When are item intercept differences substantively relevant in measurement invariance testing?. In *Methods, Theories, and Empirical Applications in the Social Sciences* (pp. 97-104). VS Verlag für Sozialwissenschaften.
- Millsap, R. E., & Yun-Tein, J. (2004). Assessing factorial invariance in ordered-categorical measures. *Multivariate Behavioral Research*, 39(3), 479-515.

- Muller, D., Judd, C. M., & Yzerbyt, V. Y. (2005). When Moderation is Mediated and Mediation is Moderated. *Journal of Personality and Social Psychology*, 89(6), 852
- Muthén, B., & Asparouhov, T. (2012). Bayesian structural equation modeling: a more flexible representation of substantive theory. *Psychological methods*, 17(3), 313.
- Hu, L. T., & 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.
- Oberski, D. L. (2014). Evaluating Sensitivity of Parameters of Interest to Measurement Invariance in Latent Variable Models. *Political Analysis*, 22(1), 45-60.
- Quinn, K. M. (2004). Bayesian Factor Analysis for Mixed Ordinal and Continuous Responses. *Political Analysis*, 12(4), 338-353.
- Saris, W. E., Satorra, A. & van der Veld, W. M. (2009). Testing Structural Equation Models or detection of Misspecifications? *Structural Equation Modeling*, 16(4), 561- 582
- Satorra, A., & Bentler, P. M. (2010). Ensuring Positiveness of the Scaled Difference Chi-Square Test Statistic. *Psychometrika*, 75(2), 243-248.
- Welzel, C., & Inglehart, R. F. (2016). Misconceptions of Measurement Equivalence: Time for a Paradigm Shift. *Comparative Political Studies*, 49(8), 1068-1094.
- Western, B. (1999). Bayesian Analysis for Sociologists: An Introduction. *Sociological Methods & Research*, *28*(1), 7-34.
- Zhao, X., Lynch, J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis. *Journal of Consumer Research*, 37(2), 197-206.

13.3 SEM software tutorials

- Epskamp, S. (2015). *semPlot*: Unified visualizations of structural equation models. Structural Equation Modeling: A Multidisciplinary Journal, 22(3), 474-483.
- Rosseel, Y. (2012). *lavaan*: An R package for structural equation modeling. Journal of Statistical Software, 48(2), 1-36.
- Rosseel, Y. (2013). The *lavaan* tutorial. https://dornsife.usc.edu/assets/sites/210/docs/GC3/lavaan_tutorial.pdf

13.4 Useful Web Links

- Quick-R: http://www.statmethods.net/
- *semPlot*: http://sachaepskamp.com/semPlot
- The R Project for Statistical Computing: https://www.r-project.org/
- The *lavaan* project: http://lavaan.ugent.be/
- Structural equations: http://www.structuralequations.com/index.html

- Structural equation modeling by David Kenny: http://davidakenny.net/cm/causalm.htm
- MPLUS official website: https://www.statmodel.com/
- http://statistics.ats.ucla.edu/stat/
- Introductory blavaan materials: https://www.rensvandeschoot.com/tutorials/blavaan-how-to-get-started/

13.5 Online Data Sources

http://sophist.hse.ru/eng/ – Joint Economic and Social Data Archive

http://www.europeansocialsurvey.org – European Social Survey

http://www.europeanvaluesstudy.eu – European Values Study

http://www.worldvaluessurvey.org – The World Values Survey Association

13 Equipment

- It is better to have your own personal laptop with R (and maybe Rstudio) software installed (though it is also possible to use university computers for completing home assignments and performing in-class labs). You can read detailed R installation instructions here or simply download the latest version here.
- We will use an R package *lavaan* as our main software. In some applications, we will also use R packages *semPlot*, *semTools*, and *blavaan*. So, given that you're confident in your R skills, you are encouraged to (1) install these packages on your laptop and (2) take a brief look at their manuals before the start of the course. However, it is not obligatory.
- Academic support for the course is provided via a course Dropbox folder, which contains all recommended readings, presentations of lectures, and replication code and data for empirical examples. To get access to this folder, please send a request to: bssokolov@gmail.com

If you have questions about the course material, computational issues, or other course-related issues please do not hesitate to contact me via e-mail: bssokolov@gmail.com. Note however that I have a very busy inbox so it may take one or two days for me to respond.

Good luck and have fun!

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