

# Rotman

## Quantitative Methods in the Applied Behavioral Sciences

RSM 3090 (Fall, 2014)

Thursdays 1-4pm, Rotman South Building 6024 (95 St. George Street)

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### Course Description

A defining feature of scholarship in the applied behavioral sciences is its emphasis on empirical research, by collecting data and submitting it to quantitative analysis. This course covers fundamental issues in conducting the analysis of quantitative data collected in fields such as management, marketing, industrial relations, psychology, and related fields. It is designed for doctoral students who intend to conduct empirical research publishable in scholarly journals. It is intended to follow RSM3062 (or its equivalent), which covers research methodology.

This course covers model building and analysis, including topics such as an introduction to statistical inference, analysis of variance, regression analysis, testing and interpreting interaction effects, mediation analysis, hierarchical linear modeling, aggregation across levels of analysis, path analysis, factor analysis, and longitudinal approaches.

A core focus of this course is on doing analyses that reflect current research in the applied behavioral sciences. Students are assigned core readings and, when appropriate, are given real empirical data to apply the method under discussion. As a prerequisite, students should have a full understanding of basic statistics and should have taken RSM3062 (or its equivalent).

### Course Requirements

Students are required to fully participate at weekly class meetings. Each meeting will include a discussion of readings and reporting of any assigned homework, including data analyses. Students are expected to read all materials. Students also must turn in written answers to the assigned homework questions. The answers are due at the beginning of each class. The answers should be brief (2-4 pages, single spaced) and to the point. When analyses are involved, written answers must include supporting results such as excerpts from computer output and brief summary tables, appended to the end of the answers. The written answers serve two purposes. First, this course emphasizes hands-on application of various methodological tools, and for learning purposes, there is no substitute for using these tools and summarizing the results in writing. Second, written answers to homework questions provide an important means of monitoring learning throughout the course. If these answers show that certain topics are not well understood, they will be reviewed in class. Students may consult with each other regarding the concepts and principles underlying the methods used. Written answers, however, should represent the work of each individual student.

Also, as a general assignment for all class meetings, all students should bring one or more discussion questions based on the assigned readings and data analyses and be prepared to initiate a discussion of the questions. These questions will be addressed as time permits.

Students must have access to statistical software for the assignments. We will conduct analyses using Windows versions of SPSS, which is available at the Rotman School of Management. Guidance will be provided regarding the use of this software (e.g., sample input files, answers to basic questions). Students may also find it useful to seek help from software documentation and web pages devoted to the software. Students who use other software are responsible for importing the provided data files into their software. Trial and Student versions of HLM and SPSS AMOS will be used during the classes on HLM, Path Analysis, and Confirmatory Factor Analysis.

## Grading

Written answers to homework assignments will constitute 100% of the final grade. Students who complete all 10 assignments on time will have their best 9 assignments included in the calculation of their final grade. All assignments will be given the same weight. Please email me a copy of your work **before each class** and bring an additional hard copy to the lecture. Students will receive their grades along with comments on their work at the end of the following class.

## Required Reading Materials

Required reading materials for the course include book chapters and journal articles. The complete references for all of the readings are included in this syllabus.

## Building your Library

In addition to the readings for the class, the following books and references provide helpful information, and you may wish to acquire these books as you progress in your career.

Primarily for methods/psychometrics:

- Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis*. Mahwah, NJ: Lawrence Erlbaum.
- Abelson, R. P. (1995). *Statistics as principled argument*. Mahwah, NJ: Lawrence Erlbaum.
- Thorndike, R. M. (2005). *Measurement and evaluation in psychology and education* (7<sup>th</sup> ed.). Upper Saddle River, NJ: Prentice Hall.

Primarily for statistics/analyses:

- For general reference: Hays, W. L. (1994). *Statistics* (5<sup>th</sup> ed.). New York, NY: Harcourt Brace College Publishers.
- For general reference: Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5<sup>th</sup> ed.) Boston, MA: Allyn and Bacon.
- For analysis of variance: Keppel, G., & Wickens, T.D. (2004). *Design and analysis: A researcher's handbook* (4<sup>th</sup> ed.). Upper Saddle River, NJ: Prentice Hall.
- For regression analysis: Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis in the behavioural sciences* (3<sup>rd</sup> ed.). Mahwah, NJ: Lawrence Erlbaum.
- For Structural Equation Modeling: Kline, R. B. (2005). *Principles and practice of structural equations modeling* (2<sup>nd</sup> edition). New York, NY: Guilford Press.
- For Hierarchical Linear Modeling: Snijders, T. A. B., & Boskers, R. J. (1990). *Multilevel analysis*. Thousand Oaks, CA: Sage.

## Summary of Topics

### **Session 1 (September 11). Introduction to the Course and the Role of Theory**

**Session 2 (September 18). Inferential Statistics:** Introduction to inferential statistics. Sampling distributions. T-tests, power analysis, and effect sizes.

**Session 3 (September 25). Analysis of Variance:** F-tests relative to t-tests. Orthogonal contrasts. Two-way interaction tests. Simple effect tests. ANCOVA.

**Session 4 (October 2). Correlation and Regression Analysis:** Value and limitations of ordinary least square regression. Categorical and continuous predictors. Handling missing data and outliers.

**Session 5 (October 9). Interaction Effects in Regression Analysis:** Meaning of interaction. Estimating interactions between various combinations of categorical and continuous variables. Plotting interactions. Higher-order interactions.

**Session 6 (October 16). Statistical Mediation and Control:** The meaning and uses of statistical control in analysis of variance and regression analysis. Simple, semi-partial, and partial correlation. Partitioning explained variance. Testing mediation. Introduction to moderated mediation and mediated moderation. Suppressor variables.

**Session 7 (October 23). Aggregation and Levels of Analysis Issues:** Introduction to levels of analysis in organizational research. Theoretical and empirical support for aggregation of constructs across levels of analysis.

**Session 8 (October 30). Hierarchical Linear Modeling – Part 1:** Identifying non-independence. Analysis of observations nested within larger units.

**Session 9 (November 6). Hierarchical Linear Modeling – Part 2:** Interactions between variables at different levels of analysis (i.e., cross-level interactions).

**Session 10 (November 13). Path Analysis:** Exogenous and endogenous variables. Direct and indirect effects. Decomposition and reproduction of correlations. Assessing model fit.

**Session 11 (November 20). Exploratory and Confirmatory Factor Analysis:** Model specification, identification, and estimation. Assessment of model adequacy and fit. Modeling of method factors. Assessing discriminant validity.

**Session 12 (November 27). Longitudinal Analysis:** Repeated Measure ANOVA/Regression, Individual and Latent Growth Models, Survival Analysis.

## Readings

(Readings subject to change with advance notice)

### 1. Introduction to the Course (no required readings)

*Recommended:*

- Brief A.P., & Dukerich J.M. (1991). Theory in organizational-behavior - can it be useful? *Research in Organizational Behavior*, 13, 327-352.
- Sutton R.I., & Staw, B.M. (1995). What theory is not. *Administrative Science Quarterly*, 40(3), 371-384.
- Whetten, D.A. (1989). What constitutes a theoretical contribution? *Academy of Management Review*, 14(4), 490-495.

### 2. Introduction to Inferential Statistics

- Hays, William L. (1994). *Statistics* (5th ed.). New York, NY: Harcourt Brace College Publishers.
  - Chapter 7 (Hypothesis testing, pp. 267-310)
  - Chapter 8 (Inferences about Population Means, pp. 311-328) – read thru sec. 8.10
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112, 155-159.
- Rosnow, R.L., & Rosenthal, R. (2003). Effect sizes for experimenting psychologists. *Canadian Journal of Experimental Psychology*, 57(3), 221-237. Read pp. 221-224.
- Hemphill, J. F. (2003). Interpreting the magnitudes of correlation coefficients. *American Psychologist*, 58(1), 78-79.

*Recommended:*

- Prentice, D.A., & Miller, D. (1992). When small effects are impressive. *Psychological Bulletin*, 112(1), 160-164.

### 3. Analysis of Variance

- Keppel, G., & Wickens, T.D. (2004). *Design and analysis: A researcher's handbook* (4th ed.). Upper Saddle River, NJ: Prentice Hall.
  - Chs. 2, 3, 4 (one-way analysis of variance, pp. 15-84)
  - Chs. 10, 11, 12 (two-way interactions, pp. 193-262)

*Recommended:*

- The rest of this book! Keppel, G., & Wickens, T.D. (2004). *Design and analysis: A researcher's handbook* (4th ed.). Upper Saddle River, NJ: Prentice Hall.

#### 4. Correlation and Regression Analysis

- Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis: An integrated approach*. Hillsdale, NJ: Erlbaum. Chapters 17, 18, and 19.

*Recommended:*

- **The entire book!** Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3<sup>rd</sup> ed.). Mahwah, NJ: Erlbaum.
  - Ch. 2 (bivariate correlation and regression)
  - Ch. 3 (multiple regression)
  - Ch. 5 (data analytic strategy using multiple regression)

#### 5. Interaction Effects in Regression Analysis

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: testing and interpreting interactions*. Thousand Oaks, CA: Sage. Chapters 1 to 4, 7.

*Recommended:*

- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3<sup>rd</sup> ed.). Mahwah, NJ: Erlbaum.
  - Ch. 7 (interactions among continuous variables)
  - Ch. 9 (interactions with categorical variables)

#### 6. Mediation and Control

- 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, 1173-1182.
- Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods*, 7, 422-445.
- MacKinnon, D. P., Fairchild, A.J., & Fritz, M.S. (2007). Mediation analysis. *Annual Reviews in Psychology*, 58, 593-614.
- Fritz, M. S., & MacKinnon (2007). Required sample size to detect the mediated effect. *Psychological Science*, 18, 233-239
- Becker, T.E. (2005). Potential problems in the statistical control of variables in organizational research: A qualitative analysis with recommendations. *Organizational Research Methods*, 8(3), 274-289.
- Spector, P.E., Zapf, D., Chen, P.Y., & Frese, M. (2000). Why negative affectivity should not be controlled in job stress research: Don't throw out the baby with the bath water. *Journal of Organizational Behavior*, 21, 79-95.

*Recommended:*

- Preacher, K.J., & Hayes, A.F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments & Computers*, 36(4), 717-731.
- Cohen, J., Cohen, P., West, S.G., & Aiken, L.S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed, pp. 64-86). Mahwah, NJ: Erlbaum.
- James, L., & Brett, J.M. (1984). Mediators, moderators and tests for mediation. *Journal of Applied Psychology*, 69(2), 307-321. Focus on distinguishing moderated mediation and mediated moderation.
- 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), 852-863.
- Edwards, J.R., & Lambert, L.S. (2007). Methods for integrating moderation and mediation: A general analytical framework using moderated path analysis. *Psychological Methods*, 12, 1-22.
- For more about bootstrapping, see Efron, B., & Tibshirani, R. (1993). *An introduction to the bootstrap*. New York: Chapman & Hall/CRC.

## 7. Aggregation and Levels of Analysis Issues

- Chan, D. (1998). Functional relations among constructs in the same content domain at different levels of analysis: A typology of compositional models. *Journal of Applied Psychology*, 83, 234-246.
- James, L. R., Demaree, R. G., & Wolf, G. (1984). Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology*, 69, 85-98.
- Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations* (pp. 349-381). San Francisco, CA: Jossey-Bass, Inc.
- Klein, K. J., Bliese, P. D., Kozlowski, S. W. J., Dansereau, F., Gavin, M. B., Griffin, M. A., Hofmann, D. A., James, L. R., Yammarino, F. J., and Bligh, M. C. (2000). Multilevel analytical techniques: Commonalities, differences, and continuing questions. In K. J. Klein and S. W. J. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations* (pp. 512-553). San Francisco: Jossey-Bass. Focus on pp. 512-520 on aggregation.

*Recommended:*

- Kenny, D. A., & La Voie, L. (1985). Separating individual and group effects. *Journal of Personality and Social Psychology*, 48(2), 339-348. (Intraclass correlation discussion)
- Roberson, Q.M., Sturman, M.C., & Simons, T.L. (2007). Does the measure of dispersion matter in multilevel research? A comparison of the relative performance of dispersion indexes. *Organizational Research Methods*, 10, 564-588.

## 8. Hierarchical Linear Modeling

- Hofmann, D. A. (1997). An overview of the logic and rationale of hierarchical linear models. *Journal of Management*, 23, 723-744.
- Singer, J. D. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. *Journal of Educational and Behavioral Statistics*, 24, 323-355.
- Bliese, P. D. (2002). Multilevel random coefficient modeling in organizational research: Examples using SAS and S-Plus. In F. Drasgow and N. Schmitt (Eds.), *Measuring and analyzing behavior in organizations* (pp. 401-445). San Francisco: Jossey-Bass.
- Hofmann, D. A. & Gavin, M. B. (1998). Centering decisions in hierarchical linear models: Implications for research in organizations. *Journal of Management*, 24, 623-641.

### *Recommended:*

- Kenny, D. A., Mannetti, L., Pierro, A., Livi, S., & Kashy, D. A. (2002). The statistical analysis of data from small groups. *Journal of Personality and Social Psychology*, 83, 126-137.
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Newbury Park, CA: Sage.

## 9. Path Analysis

- Raykov, T., & Marcoulides, G. A. (2000). *A first course in structural equation modeling*. Mahwah, NJ: Lawrence Erlbaum. Chapters 2-3 (in Chapter 2, focus on the LISREL syntax).
- MacCallum, R. C., Wegener, D. T., Uchino, B. N., & Fabrigar, L. R. (1993). The problem of equivalent models in applications of covariance structure analysis. *Psychological Bulletin*, 114, 185-199.
- Millsap, R. E. (2002). Structural equation modeling: A user's guide. In F. Drasgow and N. Schmitt (Eds.), *Measuring and analyzing behavior in organizations* (pp. 257-301). San Francisco: Jossey-Bass. Read pp. 268-287 on parameter estimation and fit evaluation.

### *Recommended:*

- Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford.
  - Chs. 4 and 5 (introduction and details of path analysis)

## 10. Exploratory and Confirmatory Factor Analysis

### *Theory and Framework*

- Tucker, L., & MacCallum, R.C. (1997). General concepts and objectives of factor analysis. In Tucker & MacCallum, *exploratory factor analysis* (Ch.1, pp.1-18). Available: <http://www.unc.edu/~rcm/book/factornew.htm>

- Browne, M.W., & MacCallum, R.C. (1998). Course notes for introduction to factor analysis. Modules 1, 2: Introduction and History. The Ohio State University, Columbus.

*Exploratory factor analysis (EFA):*

- Browne, M.W., & MacCallum, R.C. (1998). Course notes for introduction to factor analysis. Modules 6, 8: Fitting factors to data and evaluation of factors. The Ohio State University, Columbus.
- Conway, J.M., & Huffcutt, A.I. (2003). A review and evaluation of exploratory factor analysis practices in organizational research. *Organizational Research Methods*, 6(2), 147-168.

*Confirmatory factor analysis (CFA):*

- Browne, M.W., & MacCallum, R.C. (1998). Course notes for introduction to factor analysis. Modules 12-13: confirmatory factor analysis. The Ohio State University, Columbus.

*Recommended:*

- MacCallum R.C., Widaman, K.F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, 4(1), 84-99.
- Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford.

## 11. Longitudinal Analysis

- Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis*. New York, NY: Oxford University Press. Chapter 1.
- Willett, J. B. (1997). Measuring change: What individual growth modeling buys you. *Change and development: Issues of theory, method, and application*, 213, 243.
- Preacher, K. J., Wichman, A. L., MacCallum, R. C., & Briggs, N. E. (2008) Latent Growth Curve Modelling (Chapter 1).
- Duncan, T. E., & Duncan, S. C. (2009). The ABC's of LGM: An introductory guide to latent variable growth curve modeling. *Social and personality psychology compass*, 3(6), 979-991.

*Recommended:*

- 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.
- Chan, D. (1998). The conceptualization and analysis of change over time: An integrative approach incorporating longitudinal mean and covariance structures analysis (LMACS) and multiple indicator latent growth modeling (MLGM). *Organizational Research Methods*, 1(4), 421-483.