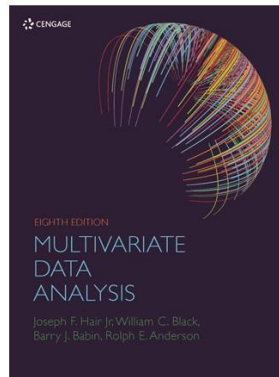NEW Eighth Edition

Multivariate Data Analysis, Eighth Edition

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Documentation of Software Syntax and Output

Previous editions of *Multivariate Data Analysis* had focused exclusively on the use of IBM SPSS for the multivariate techniques and LISREL for the SEM analyses. In the Eighth Edition we have expanded our use of software programs primarily due to the expanded set of analyses included in this edition and the desire to provide the full range of results available from the most widely available software programs. To this end we employ five software packages in varying degrees in this edition.

To allow readers to reproduce results like those presented in the text, and to explore analyses beyond those presented, we provide examples of the necessary syntax/templates for these software programs (e.g., .SPS files for SPSS, .SAS files for SAS and .AMW files for AMOS and LISREL files, which are plain text format, and use various conventions (LS8, LIS, depending on version of the software). Moreover, we include PDF versions of the output files corresponding to these syntax files so that readers who do not have access to the specific software can review the results as well. From these basic syntax files the reader can adapt the commands to perform additional analyses for these datasets as well as adapt them to other research projects.

Five Software Programs

Brief descriptions of the six software programs used within the Eighth Edition follow:

1. **IBM SPSS** – the primary software program used in the previous editions, IBM SPSS remains as the principal software program for all of the multivariate techniques

(Chapters 2 through 8) and the SEM software also distributed with IBM SPSS (AMOS) is used in Chapters 9 to 12.

2. **SAS** – one of the major software programs in addition to SPSS, SAS is used in several chapters (Chapter 4 -- Cluster Analysis, Chapter 5 – Multiple Regression, and Chapter 8 – Logistic Regression). SAS is used to provide supplemental analyses that are not available in IBM SPSS (e.g., the CCC measure in Cluster Analysis) or analyses that are portrayed in a more user-friendly manner (e.g., the residual-leverage chart in Multiple Regression or classification results for multiple cutoff points in Logistic Regression). All of the analyses performed by IBM SPSS can be replicated in SAS and we will work towards development of comparable SAS commands to those provided for IBM SPSS.

3. **LISREL** –Linear Structural Relations, includes routines for running full-information, analysis of covariance structures, meaning covariance-based SEMs. LISREL was used to estimate much of the SEM results presented in Chapters 9-12. In particular, the HBAT CFA and Structural Models were estimated with LISREL.

4. **AMOS** – has been available through SPSS for some years now and thus, anyone with access to SPSS should be able to enable the AMOS add-in. AMOS template files (.amw) are included to produce the CFA, structural, and multigroup analyses depicted in chapters 10 – 12.   All of the CB-SEM models in Chapters 9-12 can be estimated with AMOS, LISREL, lavaan, mPlus, EQS, or any of the other popular CB-SEM software packages. However, users should expect the precise results to vary slightly from software to software. For instance, one will find slight differences in reproducing the CFA model between AMOS and LISREL and lavaan. The reasons for the differences are due to differing assumptions about data standardization, stopping rules for iterative routines, treatments of missing data, etc., that are necessarily built into each program. Thus, do not be alarmed if the results using one software vary slightly from those from another or from the results shown in the Chapters. One key to knowing if the setup is correct across programs is the number of degrees of freedom provided with the output. The degrees of freedom are strictly under the control of the user in all and will match with matching setups across all SEM software.

5. **SmartPLS** – this software is used to perform the analyses in Chapter 13. PLS_SEM is another form of structural equation model using the PLS algorithm for model estimation. The software is completely menu-driven, so there are no syntax files. The user, however, can easily replicate the model being analyzed provided in the output files. The software can be downloaded at https://www.smartpls.com/.

6. **PROCESS Macro** – while technically a macro that can be used with either IBM SPSS or SAS, PROCESS is used for testing many different forms of mediation and moderation models. Developed and distributed by Dr. Andrew Hayes, the macro is available at http://www.processmacro.org for either IBM SPSS or SAS.

7. **<u>Other macros</u>** – a number of other macros are examined for addressing specific analyses that are not yet integrated into the major software programs of IBM SPSS or SAS. At this time these macros calculate measures of relative importance relating to commonality, dominance analysis and relative weights (Chapter 5 – Multiple Regression). These macros are documented within the syntax files and interested readers should always check their original sources for updated versions to those demonstrated in the text.

Output Files

Output files for the basic analyses in each chapter are available in PDF format to allow readers to review the content and format of output if software is not available. We have attempted to provide a representative demonstration of each software package, but interested readers can explore additional options available to provide further insights into the results. SmartPLS output is provided in Excel format to allow for all portions to be included in a single file.