Mastering Research Statistics

CHUA YAN PIAW

2nd Edition

McGraw Hill
Professor Chua Yan Piau completed this second edition of *Mastering Research Statistics* while on sabbatical at the University of Sussex. Having worked as a teacher and researcher in the social sciences for many years, there are students and colleagues who, for reasons of lack of opportunity, confidence or research interests, have not engaged in quantitative analysis of research data. As such, high quality and clear textbooks (like this book) that can be used by novice quantitative researchers are essential. For those with more experience in this area, it is still always important to have such a textbook as *Mastering Research Statistics* on hand for reference purposes or to refresh their memory.

Gillian Hampden-Thompson, PhD  
Professor of Education  
Head of the School of Education and Social Work  
University of Sussex, UK

*Mastering Research Statistics, 2nd Edition*, is a practical guide for those who are directly involved in research. It covers basic research statistics which can be used as teaching and learning tool for courses related to research at both undergraduate and post-graduate levels. This book can also be used as a reference by researchers when they are conducting and reporting their research. Not only does *Mastering Research Statistics, 2nd Edition*, introduce readers to methods of conducting research, it helps them to easily understand the entire research process, including designing the research instrument, data entry and data analysis, and reporting the results.

Explanations about the concepts of research, especially the research design, measurement and format of research reports, are simplified to help readers at all levels of English proficiency better understand what they are reading. Exercises are provided at the end of each chapter to help readers reinforce their understanding of the topics covered in the chapter.

In addition, a new chapter titled “An Introduction to Data Analysis with Structural Equation Modeling” has been added to this edition. It not only introduces the basic concepts of SEM analysis, but also provides examples of SEM research and step-by-step data analysis methods using AMOS and SmartPLS.
Mastering Research Statistics

Second Edition

McGraw Hill
To

Bok Kai Wa
Yee Pei, Wan Xin and Jing Xin
who are the main sources of my happiness
and

to the memory of my parents
Chua Yan Piaw is a professor at the Institute of Educational Leadership, Faculty of Education, University of Malaya, Malaysia, where he teaches research methods and statistics courses. He worked as a research statistics consultant from 2010 to 2015 at the Unit for the Enhancement of Academic Performance, UM, which was set up to increase the percentage of academic staff with PhD qualification. He has also supervised 22 PhD students until graduation between 2008 and 2018.

His book series, "Research Methods and Statistics", book 1 to book 5 with 62 chapters, is listed among McGraw Hill's Top 10 Bestselling Titles in Malaysia. A book in the series, "Mastering Research Methods, Second Edition" was awarded the 2018 Book Publication Award by the University of Malaya. He is an author, reviewer and editorial board member of Web of Science ISI journals (Social Science Citation Index). He was awarded the 2017 and 2018 Outstanding Journal Reviewer Award and the 2016 Excellent Reviewer Award by Elsevier for his contribution in reviewing journal articles of a Tier 1 ISI Journal, that is, the Computers in Human Behavior Journal in the Thomson Reuters Social Science Citation Index. He has published books in various fields, including creative and critical thinking, multiple intelligence, educational leadership, arts education, chemistry, science and calligraphy.

He has won six gold medal awards at various international invention and innovation expos and is also the winner of five gold medals awarded at World Peace Painting and Calligraphy Exhibitions.

In addition, he was a speaker for more than 100 research methods and data analysis (using AMOS, SPSS and SmartPLS) workshops. From 2015 to 2017, he was invited by the Institute of Graduate Studies to conduct 38 data analysis workshops (a duration of 14 hours each) for postgraduate students at the Universiti of Malaya with the aim of enhancing their data analysis skills under the upskill programme. Between 2015 and 2016, he was invited by the National Sports Institute of Malaysia to conduct 12 statistics workshops for biomechanics, nutritionists and psychologists to enhance their data analysis and report writing skills.
The desire to write a research book arose when I was working as a facilitator for a 12-week research course for lecturers. For two years, off-duty hours and what was supposed to be family time were spent planning and writing this book.

During the writing process, I was both the author and reader. As the author, I tried to write the book professionally, to provide valid, reliable, up-to-date, useful and practical information to the readers. Then I read my own writing in the way would somebody with little knowledge of research. After playing the roles of author and reader and rewriting and rereading the manuscript, the book was finally completed.

Those who are directly involved in the field of research will find this book useful. It is appropriate to be used as the teaching and learning material for courses which are related to research statistics at all undergraduate and post-graduate levels. This book can also be used as a reference by researchers when they are conducting and reporting their research.

Explanations about the concepts of research, especially the design, measurement, data analysis with SPSS and report of analysis, are simplified to help readers of all levels better understand what they are reading. Concepts are explained in detail with examples and text-related illustrations to enable readers to carry out confidently each stage of the research process. Exercises are provided at the end of each chapter to help readers reinforce their understanding of the topics covered in the chapter.

In this second edition, a new chapter titled “An Introduction to Data Analysis with Structural Equation Modeling” has been added. It not only introduces the basic concepts of SEM analysis, but also provides examples of SEM research and step-by-step data analysis methods using AMOS and SmartPLS. Those who are doing structural equation modeling studies will find this chapter a user-friendly guide for SEM data analysis.

I hope readers at all levels will be able to benefit fully from this book in their efforts to realise their aims and hopes through research activities and self-development in this era of globalisation.

Never ever give up!

Chua Yan Piaw
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Finally, I would like to thank everyone else who has contributed directly and indirectly to the production of this book. Thank you very much.

Chua Yan Piaw

**COMMENTS AND RESPONSES**

The author welcomes comments and responses from readers. Please send them to: yanpiaw@gmail.com or chuapp@um.edu.my. Thank you.
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PART 1

THE TWO TYPES OF RESEARCH STATISTICS

Part 1 consists of two chapters.

CHAPTER 1 discusses DESCRIPTIVE STATISTICS which are used to directly describe the characteristics of a variable in a population.

CHAPTER 2 discusses INFERENTIAL STATISTICS AND THE SIGNIFICANCE TEST which describes the characteristics of the variable in a population based on characteristics of the sample.
Quantitative research deals with numbers and statistics. It is important for a researcher to understand the concept of statistics before analysing his data. Without a knowledge of statistics, it will be hard to analyse, understand and describe the data collected. There are two types of statistics: descriptive statistics and inferential statistics.
Structural Equation Modeling (SEM) is recently popular in social sciences research. It is an important data analysis technique especially in social sciences, education, business and economic studies, as well as in certain fields of medical studies.

Dear professor, can my stress model with hundreds of direct and indirect factors be applied to the population?
(1) The motivation measurement model
(2) The thinking style measurement model
(3) The creativity measurement model

![Diagram](image)

**Figure 13.3:** Three measurement models

Each measurement model has **three components**. For example, the motivation measurement model has:

(a) the **latent variable**, Motivation, in the large circle
(b) three **measurement items (or indicators)** in rectangular boxes
(c) three **measurement errors** in small circles, labelled as $e_7$, $e_8$ and $e_9$

### b. Single-headed Arrows

There are three **single-headed arrows** pointing to the three measurement items from the latent variable **Motivation**, each with the value .85 (Intrinsic), .84 (Extrinsic) and .76 (Social). The values are **loadings** of the latent variable motivation on its three measurement items. The loadings indicate **convergent validity** of the items in measuring the concept of motivation. A measurement item should have a loading of $\geq .50$. Any measurement item that has a loading of $< .50$ is considered less valid in terms of convergent validity because the latent variable motivation can only explain less than 25% of the variance of the indicator; thus, the indicator can be deleted from the measurement model if deleting it does not affect the overall concept of motivation based on theory. [The above loading value is based on the benchmark of the covariance-based SEM model; for variance-based SEM, the loading should be $\geq .70$.]
5. **Fifth Step: Analysing the Hypothesised Model**

**Steps**

1. Click the “Analysis Properties” ( méthodologie ) icon. Select Output and then tick the box “Standardised estimates” and “Squared multiple correlations”. Then close the Analysis Properties dialog box.
AMOS suggested the model fit be improved by connecting the external factors (measurement errors) e3 and e4 with a **double-headed arrow**. Then the chi-square value would be reduced by at least **19.175** (M.I. = 19.175).

Click the **“Calculate estimates”** icon to run the analysis on the model again. The output of the modified hypothesised model is indicated in Figure 13.6.

**Figure 13.6**: Results of covariance-based SEM analysis
7. To draw the **single-headed arrows** from the three independent latent variables **Education’s impact**, **Parents’ influence** and **Peers’ pressure** to the dependent latent variable **Moral value practices**, click the **Connect** button. Then draw the single-headed arrows. The SEM model is now ready for analysis.
5. Click on the indicator **education5** and press the **Delete** key on the computer keyboard to remove it from the model.

6. Repeat steps 1 to 3 to perform the **Consistent PLS Bootstrapping** analysis. The output shows that all indicators achieve **convergent validity** in terms of loadings (all loadings > 0.70, p < .05).
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