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*Statistics for
Management and
Economics* (6th ed.)

经济学经典教材·双语教学用书

统计学

——在管理和
经济学中的应用

(第六版)

杰拉德·凯勒 (Gerald Keller) 著
布赖恩·沃拉克 (Brian Warrack)

 中国人民大学出版社

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序 言

本书强调统计学的应用和基础概念。其设计偏重实用性、灵活性和新颖性。偏重实用性，其目的在于教会学生如何根据手头问题来判断选择恰当方法、计算统计量和给出合理解释。所谓灵活性，即本书以允许教师选择他们感兴趣的计算方法逐步向导的形式，给出了用手工方式和使用 Excel 与 Minitab 计算的方法，并将之贯穿全书，为教师提供了一个灵活的途径。对于使用 SPSS 或 JMP 者，本书的网站也提供了相同形式的向导。本书有 814 个数据集，它们以 Microsoft Excel 和各种主要统计软件包的格式保存。本书的新颖性在于在每一商务和经济学领域都强调统计学的应用及其如何运用。学生们可以在其主攻的模块以及覆盖全书的可选部分中学习怎样运用统计学，从在研究投资组合风险分散中如何使用概率到在市场细分中如何使用置信区间都有涉猎。所有这些可选部分都独立成篇，并且不需要学生对统计学在这些职能领域的应用有任何背景知识。

本书的目的

1971 年，在我们开始讲授统计学时，这门课程重点强调手工计算。当时的观念认为只有通过手工计算才能让学生理解各种方法和概念。计算非常耗时但对技巧的要求无非加减乘除或者开方。当时出版的练习册就是对这一观念的反映。极为讽刺的是，作为更重要的技巧，对于正确方法的识别运用却被忽略了。而这才是学生在测试中以及毕业后在运用统计分析时所需要的技能。

1988 年，我们出版了本书的第一版，其中一项重要目标就是指导学生识别恰当的方法。接下来的四版我们又做了改进，同时强调解释与决策。我们用自己的方法把各种统计技术的运用都分成三步走，并在所有的举例中都这样做：(1) 识别方法，(2) 计算统计量，(3) 解释结果。计算一步可以通过手工（使用计算器辅助）、Excel 和 Minitab 三种方式中的任一种或全部三种方式来完成。对于那些强调使用计算机方法的课程，手工计算可以简化乃至完全剔除。而对于强调手工计算的课程，亦可选讲计算机的使用或完全忽略。具体情况可由教师根据需要做出选择。

我们认为我们的思路有几项优点：

- 对识别和解释的强调使学生能够掌握可运用于其所面对问题的可行性技术，无论其所学课程偏重手工计算还是计算机的运用。
- 使学生深入体会到统计学是将数据转化为信息的一种工具。超过 800 个数据文件以及相应的需要学生解释统计结果的练习，为学生实践数据分析与决策提供了广泛的机会。

- 计算机的选用使得学生可以面对规模更大以及现实性更强的练习和案例。

本版的理念

强调不同的学习风格 如我们所知，统计学不仅仅是一套把数据处理成信息的工具。在统计学背后隐藏着许多学生需要面对的重要概念。不幸的是，许多学生惧怕统计学，因为他们认为统计学是一门需要很多数学知识的课程，并且怀疑自己在这方面非常薄弱。在本版中，我们提供了多种教学方案来适应学生们的不同学习风格。同时新引入了以基础统计概念为中心的 19 个 JAVA 控件，它们与全书融为一体。这些控件使学生能够“发现”截然不同的规律。比如，其中一个控件展示了均值的抽样分布如何产生。相关控件则展示不同分布的影响。本书中附带的 83 个控件练习可以帮助学生对 19 个控件进行准确的理解，这将有助于学生的学习。

除控件之外，我们还有多个 Excel 工作簿，在其工作表中列有置信区间估计与检验统计量。通过改变一个或多个输入值，学生可以学习到，比如增加样本容量对检验统计量的影响或者降低置信水平对区间估计的影响。我们相信这些控件和工作表将对那些不熟悉统计学的学生有帮助，并使得所有学生对统计概念有更深入的理解。

集中于应用 在实践中，统计分析并不是空谈。相反，统计学在几乎所有的管理与经济学领域的决策中都被当作工具来使用。越来越多的学校在其商科教育中采用了一体化的课程。一体化课程体现了不同课程在决策中的共同运用。比如，对一项新产品的推介的决策同时涉及营销学、财务以及运营管理。把一项决策分割到任何一个独立功能领域在实践中是不可能的，也是不现实的。

我们认为统计学恰恰位于所有商业与经济决策的中心位置。比如，消费者调查与市场检验的统计分析能够告诉营销经理一个细分市场有多大规模。统计学可以在多个方面帮助生产经理。通过实验设计，生产经理可确定运用哪些工艺、机器、原料以及人力可以生产出高质量产品。统计学还能帮助生产工厂选址、规划建设以及预测需求。

不幸的是，多数学生在选择商学领域的其他课程之前就上了统计学课程。如果学生对市场学、财务学、运营学以及其他知识知之甚少，那我们怎样来讲授这些领域的应用统计学呢？我们可以在讲统计应用之前先概括地介绍一下相关知识。

在这些应用中的每一项都可选择时，我们发现这对那些提出“我该如何运用这些技术”的学生有明显促进。我们把对它们的解释为教师和学生做得足够简单。学生所不熟悉的商业领域统计应用的例子以应用窗口的形式给出，在其中对应用作了解释。比如，为了例举图形技术我们引入了一个例子对比了两项不同投资的回报的直方图。为了解释财务分析可以在直方图中得到什么，我们需要理解风险是以回报的总方差来测度的。举例之前有一个“在财务中的应用”窗口出现，讨论了投资回报如何计算与运用。接下来当我们给出正态分布，我们引入了另一个在财务中的应用窗口来解释为什么回报的标准差可以测度投资风险。36 个应用窗口贯穿全书。

有些应用规模庞大，我们就用一个单独的标题列出。例如，在介绍比例的置信区间估计的那一章，我们也介绍了市场细分。在那一部分我们展示了如何把一个总体比例的置信区间估计用于市场细分规模的估计。在其他章节我们通过展示市场经理如何把这些技术运用于确定市场分割之间存在的差异，来例举了多种统计技术。这种情况在本书的五个部分中出现了。

本书的特有思路

教授方法识别技巧 导引（见前插页）、流程图与回顾章节讲授了这一重要的技巧。文中的每一个举例都会凸现运用某一特定技术的理念。所介绍的每一技术都伴有对其进行识别运用的特征性因素。

提供复习章节 每一章节末的练习与案例自然需要运用在该章介绍的技术。但是，在后面考试中或在商务世界里，是不会有这种指导提供给学生的。为了帮助学生进一步掌握方法识别技巧，本书的两个复习章节（14 章和 24 章）包括练习和案例在内都需要对前面介绍的方法进行运用。每一个复习章节都提供了一个流程图以指导学生确定适用的统计方法。

使用 Excel 与 Minitab 两个软件包贯穿全书被广泛运用于统计量的计算。绝大多数例子都同时给出了手工、Excel、Minitab 三种解答方案，使学生可以同时看到所有解答并运用之。这提供了很大的弹性，教师可以选择何时偏重手工与计算机运算，并确定是扩展表还是统计软件更适用。

给出计算机向导 针对 Excel 与 Minitab 的向导窗口使教师与学生易于运用计算机。这也使得教师无需教授软件的使用，而学生无需购买额外的 Excel 与 Minitab 手册。此外，第六版还在图书网址上新给出了 SPSS 和 JMP 的向导，直接对应于书中的 Excel 与 Minitab 向导。

提供了数据分析插件 4.0 新建了 Excel 宏以完善 Excel 的统计菜单。本书中介绍的所有统计技术都可以运用 Excel 的分析快捷工具或 4.0 版本的数据分析插件来计算。数据分析插件适配于 Office 95、97、2000 以及 XP。

提供了数据文件 对于多数的例子、练习与案例，以多种格式提供了数据文件，包括 Excel、Minitab、JMP、SPSS 以及 ASC II 等格式。第六版拥有 814 个数据文件，其中许多都有几千个观测值，这体现了本书的一个中心理念——统计技术可把数据转化为信息。对于手工进行统计分析的学生，我们给出了后面的附录 A，其中提供了对练习的归纳统计（比如均值和方差），使得绝大多数练习可以手工解决。

在例子与练习中使用现实数据 许多例子、练习与案例是基于现实数据的，这些数据来自统计工作者的工作实践与期刊、报纸和杂志等出版物或者会议论文。对大部分数据文件进行了调整，以计算其原始结果。

本版的创新之处

- 19 个控件带有总计 83 个控件练习。摘自麦克兰德（Gary McClelland）的《看图统计》并融入本书，这 19 个控件展示了统计概念，形象化地帮助学生理解其中内涵。全部存储在本书附带的 CD 中。

- 每章开头部分的例子阐述的是该章所要介绍的方法的应用。设计这些例子是为了促进学生对该章中的方法概念的理解。在该章的小结部分都会重提这一例子，此时问题已经解决。

- 改进与增加的 Excel 插件。4.0 版本的新增功能有：

- 茎叶图展示
- 允许任何数目数据集比较的多维箱线图
- 季节指数
- 分组相关（皮尔森与斯皮尔曼）插件
- 变量名的加入

- 使用了已计算统计量的新 Excel 扩展表与 what-if 分析的执行。已被用于所选的练习中，其设计目的是为了帮助学生观察改变输入如何影响统计输出。

- 可用于与投资组合及支付方程相关计算的新 Excel 扩展表。这些工作表可见于本书的财务与人力资源管理应用统计两个部分的练习与示例中。

- 应用于... 窗口，揭示如下方面的基础统计应用：

- 5 金融
- 11 市场营销
- 4 人力资源管理

- 13 运营管理
- 2 会计
- 1 经济学

● 全书通篇的 1 895 个练习中有 613 个新练习 (1 282 个已在第五版出现)。

● 814 个数据集中有 217 个新数据集 (597 个是第五版已有的)。对于想手工进行统计分析的学生, 我们给出了后面的附录 A, 其中提供了针对这些数据集的归纳统计。

● 关于决策分析的新章节 (23 章)。

● 更新与改善了的概率说明出现在新的例子与练习中 (6、7、8 章)。概率概念被从离散概率分布中分离出来以简化说明。此外, 这些章节使用了许多新的应用练习和控件以利于学生形象化地理解概念。

● 使用了许多新的例子与练习以加强描述统计章节 (2、4 两章及一个关于描述统计的包括向导与流程图的复习)。

● 用以说明附带方法与概念的新 CD 附件*。

● 使用了许多新练习的已更新的平滑预测与时间序列章节 (21 章)。

● 在统计过程控制章节新增的关于功效曲线与平均步长的部分。

● 新的 8. 5 节使得可以提前介绍三大常用分布以及其他分布。当然推后介绍也不会造成损失。

* 读者可到中国人民大学出版社的网站下载 CD 内资源。——编者注

PREFACE

Statistics for Management and Economics was written for courses that emphasize applications and fundamental concepts of statistics. It is designed to be practical, flexible, and modern. This text provides a **practical** orientation that teaches students how to identify the correct method, calculate the statistics, and properly interpret the results in the context of the question or decision at hand. The text provides a **flexible** approach to instructors by consistently presenting calculations manually and with Excel and Minitab, with accompanying step-by-step instructions allowing instructors to select the method of calculation they prefer. For those who use SPSS or JMP, the same instructions are provided on the text's Web site. Accompanying the text are 814 data sets, formatted for Microsoft Excel and all major statistical software packages. The text provides a **modern** approach that emphasizes applications and how statistics is used in every business and economics function. Students will learn how statistics is used in their chosen major in "Applications in..." boxes and optional sections throughout the text, ranging from how probability is used in portfolio diversification to how confidence intervals are used in market segmentation. All of these optional sections are self-contained and assume the student has no background in these functional area applications.

WHY WE WROTE THIS BOOK

When we first began our careers in 1971, statistics was taught with an emphasis on manual calculations. It was believed that only by doing calculations by hand would students be able to understand the techniques and concepts. Calculations were quite time-consuming but required no more skills than the ability to add, subtract, multiply, divide, and determine square roots. The textbooks published at the time reflected this pedagogy. Ironically, a more important skill, the ability to identify the correct technique to use, was neglected. This is a skill that is needed by students in writing exams and by graduates in applying statistical analyses.

An important goal in 1988 when we published the first edition of this book was to teach students to identify the correct technique. Through the next four editions we refined our approach to equally emphasize interpretation and decision making. With our approach we divide the solution of statistical techniques into three stages and include them in every appropriate example: (1) *identify* the technique, (2) *compute* the statistics, and (3) *interpret* the results. The *compute* stage can be completed in any or all of three ways: manually (with the aid of a calculator), using Excel, and using Minitab. For those courses that wish to use the computer extensively, manual calculations can be downplayed or omitted completely. Conversely, those that wish to emphasize manual calculations may easily do so and the computer solutions can be selectively introduced or skipped entirely. Our approach leaves the decision of if and when to introduce the computer up to the instructor.

We believe that our approach offers several advantages:

- Emphasis on identification and interpretation provide students with practical skills they can apply to real problems they will face whether a course uses manual or computer calculations.
- Students learn that statistics is a method of converting data into information. With over 800 data files and corresponding problems that ask students to interpret statistical results, students are provided ample opportunities to practice data analysis and decision making.
- The optional use of the computer allows for larger and more realistic exercises and examples.

RATIONALE FOR THIS EDITION

Addressing Different Learning Styles. As we know, statistics is more than just a set of tools to process data into information. There are many valuable concepts that underlie statistics to which students should be exposed. Unfortunately, many students fear statistics because they believe that it is nothing more than a required mathematics course and they perceive themselves as being weak in these skills. In this edition, we have provided several pedagogical approaches to reflect the differing learning styles among students. New in the 6th edition are 19 Java applets centered around fundamental statistical concepts, which are integrated throughout the book. These applets allow students to “discover” various principles. For example, one applet demonstrates how the sampling distribution of the mean is created. Related applets show the effect of different populations. To focus student learning, the book includes 83 applet exercises that help students glean the appropriate conceptual understanding from each of these 19 applets.

In addition to the applets, we have several Excel workbooks that feature worksheets for confidence interval estimators and test statistics. By changing one or more inputs, students can learn, for example, the effect of increasing sample sizes on test statistics or the result of decreasing the confidence level on interval estimators. We believe that these applets and worksheets will help those students who are intimidated by statistics and provide every student with a deeper comprehension of statistical concepts.

Applications in Focus. In practice, statistical analyses are not conducted in a vacuum. Instead, statistics is used as a tool in decision making in virtually all areas of management and economics. A growing number of schools have adopted an integrated approach in business education. The integrated approach shows how the different subjects operate together to make decisions. For example, decisions about the introduction of a new product lie within the domain of marketing, finance, and operations management. Separating a decision into only one of these functional areas is practically impossible and unrealistic.

We believe that statistics properly belongs in the center of almost all business and economics decision problems. For example, statistical analysis of consumer surveys and test marketing can tell the marketing manager how large a market segment is. Statistics can play several roles in assisting the operations manager. By conducting experiments, the operations manager can determine which methods, machines, materials, and personnel to employ to produce high-quality products. Statistics can also aid in deciding the location of the production plant, planning the construction of facilities, and predicting demand.

Unfortunately, most students take their statistics courses before enrolling in the other areas of business. How can we teach the applications of statistics in marketing, finance, operations, and others if students know little about these subjects? The answer is that we teach the general context of the statistical application before showing how statistics addresses the problem.

While each of these applications is presented in an “optional” way, we have found that they provide great motivation to the student who asks, “How will I ever use this technique?” We have made their introduction easy for instructors and students. Illustrations of statistical applications in business with which students are unfamiliar are preceded by an application box, which explains the application. For example, to illustrate graphical techniques we use an example that compares the histograms of the returns on two different investments. To explain what financial analysts look for in the histograms requires an understanding that risk is measured by the amount of variation in the returns. The example is preceded by an “Applications in Finance” box that discusses how return on investment is computed and used. Later when we present the normal distribution, we feature

another Application in Finance box to show why the standard deviation of the returns measures the risk of that investment. Thirty-six application boxes are scattered throughout the book.

Some applications are so large that we devote an entire section to the topic. For example, in the chapter that introduces the confidence interval estimator of a proportion, we also present market segmentation. In that section we show how the confidence interval estimate of a population proportion can yield an estimate of the size of market segments. In other chapters we illustrate various statistical techniques by showing how marketing managers can apply these techniques to determine the differences that exist between market segments. There are five such sections in this book.

KEY FEATURES OF OUR APPROACH

Teaches technique identification skills. Guides (see inside front cover), flowcharts, and review chapters develop this crucial skill. Every appropriate example in the text highlights the rationale for using a particular technique. Every technique that is introduced is accompanied by the factors that identify its use.

Offers review chapters. Exercises and cases that appear at the end of chapters naturally require the use of techniques introduced in a particular chapter. Unfortunately, students are not given such direction in future coursework or in the business world. To help further develop technique-identification skills, two review chapters (14 and 24) contain exercises and cases that require the use of techniques previously introduced. Each review chapter features a flowchart that guides students in determining the appropriate statistical method.

Uses Excel and Minitab. Both software packages are used extensively and presented consistently throughout the book to compute statistics. Most examples within chapters present manual, Excel, and Minitab solutions, allowing students to see each solution method together and to use the solution method that is preferred. This feature is provided for flexibility, allowing the instructor to decide when manual or computer calculations should be emphasized and whether a spreadsheet or statistical software is most appropriate.

Presents computer instructions. Detailed instructions for both Excel and Minitab for Windows make it easy for instructors and students to make use of the computer. They also eliminate the need for instructors to teach how to use the software and for students, the need to buy supplementary Excel or Minitab manuals. New in the 6th edition: SPSS and JMP instructions are provided on the text's Web site and directly correspond to the Excel/Minitab instructions in the text.

Provides Data Analysis Plus® 4.0. Excel macros were created to complement Excel's menu of statistical procedures. All statistical techniques introduced in this book can be computed using either Excel's Analysis ToolPak or version 4.0 of Data Analysis Plus. Data Analysis Plus® is compatible with Office 95, 97, 2000, and XP.

Data files are provided in several formats, including Excel, Minitab, JMP, SPSS, and ASCII) for most of the examples, exercises, and cases. The 6th edition includes 814 data files, some consisting of thousands of observations, which emphasize a central theme in the book—that statistical techniques convert data into information. For students who will conduct statistical analyses manually, we have provided Appendix A at the back of the book, which provides the summary statistics (e.g., means and variances) for exercises, allowing most exercises to be solved manually.

Uses realistic data in examples and exercises. Many of the examples, exercises, and cases are based on actual studies performed by statistics practitioners and published in

journals, newspapers, and magazines, or presented at conferences. Many data files were recreated to produce the original results.

NEW IN THIS EDITION

- 19 Java Applets with a total of 83 applet exercises. Adapted from *Seeing Statistics*® by Gary McClelland and customized to this text, these 19 applets present statistical concepts, visually helping students gain insight. These are stored on the CD that accompanies this text.
- Chapter opening examples illustrate uses of techniques introduced in that chapter. These examples are designed to help motivate students to learn the concepts in the chapter. Examples are revisited at the chapter's conclusion, where they are solved.
- Improved and expanded Data Analysis Plus® add-ins for Excel (allows for inclusion of the names [labels] of variables). (*Note:* For a detailed listing of capabilities, see the back cover endsheet of this text.) New capabilities in version 4.0 include:
 - Stem-and-leaf display
 - Multiple box plots allow comparisons of any number of data sets.
 - Seasonal indexes
 - Separate correlation (Pearson and Spearman) add-ins
 - Allow for the inclusion of the names of variables
- New Excel spreadsheets to employ with already-computed statistics and perform what-if analyses. These are used in selected exercises and are designed to help students see how statistical output is affected by changing inputs.
- New spreadsheets that perform calculations associated with portfolio diversification and pay equity. These worksheets are referenced in two sections of the text and selected exercises and illustrate applications of statistical techniques in Finance and Human Resource Management.
- Applications in ... boxes, which show fundamental applications of statistics in the following subjects:
 - 5 finance
 - 11 marketing
 - 4 human resources management
 - 13 operations management
 - 2 accounting
 - 1 economics
- 613 new exercises (in addition to many updated exercises) for a total of 1,895 exercises throughout the text (1,282 appeared in the fifth edition)
- 217 new data sets for a total of 814 data sets (597 in the fifth edition). For those who wish to solve the exercises containing data sets manually, we have provided Appendix A, which gives the corresponding summary statistics to these data sets.
- New chapter on Decision Analysis (Chapter 23)
- Updated and improved probability presentation with many new examples and exercises (Chapters 6, 7, and 8). Probability concepts are separated from discrete probability distributions to simplify the presentation. In addition, these chapters feature many new applied exercises and applets to help students visualize and understand concepts.

- Improved descriptive statistics chapters with many new examples and exercises [Chapters 2 and 4 and a review with guide and flowchart of descriptive statistics (appears between Chapters 4 and 5)]
- New CD Appendixes featuring additional techniques and concepts (e.g., index numbers, hypergeometric distribution). These are denoted in the Table of Contents as “CD Appendixes.”
- Updated and streamlined forecasting and time series chapter (Chapter 21) featuring many new exercises
- Added section on operating characteristic curves and average run length in statistical process control chapter (Chapter 22)
- New Section 8.5 allows the option of introducing the Student t , chi-squared, and F distributions (Chapter 8, Continuous Distributions) earlier and alongside other continuous distributions. Those who prefer to introduce these concepts later may still do so with no loss in continuity.

TEACHING AIDS

- The Instructor’s Suite CD contains solutions to every exercise (in MS Word format), over 2,800 test items containing a variety of test problems including computer exercises (authored by Mohammed El-Saidi of Ferris State University and provided in MS Word format), and Microsoft PowerPoint slides. The PowerPoint slides (authored by Zvi Goldstein of CSU Fullerton) are completely updated. Containing many animations of examples in the text, the PowerPoint slides now contain flexibility to show additional examples at the touch of a button. In addition, there are suggestions for teaching with the text such as how the computer can be used in class, assignments, and on exams.
- Instructor’s Solutions Manual. Authored by Gerry Keller, this is a printout of the solutions contained on the Instructor’s Suite CD.
- Test Items. A printed version of the test items on the CD.
- BCA Testing

LEARNING AIDS

- Student Solutions Manual. Contains worked solutions to the exercises containing answers in the back of the book. Available for purchase.
- Study Guide: Provided free in 6th edition in PDF form on the CD that accompanies this text. The Study Guide contains additional examples, worked problems, and student help.
- WebTutor for WebCT or Blackboard. Authored by Don St. Jean of George Brown College, the WebTutors are the perfect Web companion for traditional or distance courses. The WebTutors contain many study aids, including self-quizzing and tutoring help.
- Text Web Site. Go to www.duxbury.com and select “Online Book Companions”; there one can select this text and view a host of resources including software updates, typos/corrections, additional exercises, technical support, and more.

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