



教育部高校工商管理类教学指导委员会双语教学推荐教材

工商管理经典教材·核心课系列  
BUSINESS ADMINISTRATION CLASSICS

# 商务与经济统计学


英文版·第12版

詹姆斯·麦克拉夫 (James T. McClave)  
乔治·本森 (P. George Benson) 著  
特里·辛西奇 (Terry Sincich)

STATISTICS FOR BUSINESS AND ECONOMICS

..... Twelfth Edition .....



 中国人民大学出版社

全新版

教育部高校工商管理类教学指导委员会双语教学推荐教材

工商管理经典教材·核心课系列

BUSINESS ADMINISTRATION CLASSICS

# 商务与经济统计学

英文版·第12版

詹姆斯·麦克拉夫 (James T. McClave)  
乔治·本森 (P. George Benson) 著  
特里·辛西奇 (Terry Sincich)

STATISTICS FOR BUSINESS AND ECONOMICS

..... Twelfth Edition .....

中国人民大学出版社  
· 北京 ·

图书在版编目 ( CIP ) 数据

商务与经济统计学: 第12版: 英文/ 詹姆斯·麦克拉夫, 乔治·本森, 特里·辛西奇著. —北京: 中国人民大学出版社, 2017.5

工商管理经典教材·核心课系列

ISBN 978-7-300-24260-6

I. ①商… II. ①詹… ②乔… ③特… III. ①商业统计学-高等学校-教材-英文②经济统计学-高等学校-教材-英文  
IV. ①F712.3 ②F222

中国版本图书馆 CIP 数据核字 (2017) 第058424号

教育部高校工商管理类教学指导委员会双语教学推荐教材

工商管理经典教材·核心课系列

商务与经济统计学 (英文版·第12版)

詹姆斯·麦克拉夫

乔治·本森 著

特里·辛西奇

出版发行 中国人民大学出版社

社 址 北京中关村大街31号

邮政编码 100080

电 话 010-62511242 (总编室)

010-62511770 (质管部)

010-82501766 (邮购部)

010-62514148 (门市部)

010-62515195 (发行公司)

010-62515275 (盗版举报)

网 址 [http:// www. crup. com. cn](http://www.crup.com.cn)

[http:// www. ttrnet. com](http://www.ttrnet.com) (人大教研网)

经 销 新华书店

印 刷 涿州市星河印刷有限公司

规 格 215 mm × 275 mm 16开本

版 次 2017年5月第1版

印 张 32.75 插页2

印 次 2017年5月第1次印刷

字 数 954 000

定 价 66.00 元

版权所有

侵权必究

印装差错

负责调换



# 总 序

随着我国加入 WTO,越来越多的国内企业参与到国际竞争中来,用国际上通用的语言思考、工作、交流的能力也越来越受到重视。这样一种能力也成为我国各类人才参与竞争的一种有效工具。国家教育机构、各类院校以及一些主要的教材出版单位一直在思考,如何顺应这一发展潮流,推动各层次人员通过学习来获取这种能力。双语教学就是这种背景下的一种尝试。

双语教学在我国主要指汉语和国际通用的英语教学。事实上,双语教学在我国教育界已经不是一个陌生的词汇了,以双语教学为主的科研课题也已列入国家“十五”规划的重点课题。但从另一方面来看,双语教学从其诞生的那天起就被包围在人们的赞成与反对声中。如今,依然是有人赞成有人反对,但不论是赞成居多还是反对占上,双语教学的规模和影响都在原有的基础上不断扩大,且呈大发展之势。一些率先进行双语教学的院校在实践中积累了经验,不断加以改进;一些待进入者也在模仿中学习,并静待时机成熟时加入这一行列。由于我国长期缺乏讲第二语言(包括英语)的环境,开展双语教学面临特殊的困难,因此,选用合适的教材就成为双语教学成功与否的一个重要问题。我们认为,双语教学从一开始就应该使用原版的各类学科的教材,而不是由本土教师自编的教材,从而可以避免中国式英语问题,保证语言的原汁原味。各院校除应执行国家颁布的教学大纲和课程标准外,还应根据双语教学的特点和需要,适当调整教学课时的设置,合理选择优秀的、合适的双语教材。

顺应这样一种大的教育发展趋势,中国人民大学出版社同众多国际知名的大出版公司,如麦格劳-希尔出版公司、培生教育出版公司等合作,面向大学本科生层次,遴选了一批国外最优秀的管理类原版教材,涉及专业基础课,人力资源管理、市场营销及国际化管理等专业方向课,并广泛听取有着丰富的双语一线教学经验的教师的建议和意见,对原版教材进行了适当的改编,删减了一些不适合我国国情和不适合教学的内容;另一方面,根据教育部对双语教学教材篇幅合理、定价低的要求,我们更是努力区别于目前市场上形形色色的各类英文版、英文影印版的大部头,将目标受众锁定在大学本科生层次。本套教材尤其突出了以下一些特点:

- 保持英文原版教材的特色。本套双语教材根据国内教学实际需要,对原书进行了一定的改编,主要是删减了一些不适合教学以及不符合我国国情的内容,但在体系结构和内容特色方面都保持了原版教材的风貌。专家们的认真改编和审定,使本套教材既保持了学术上的完整性,又贴近中国实际;既方便教师教学,又方便学生理解和掌握。

● 突出管理类专业教材的实用性。本套教材既强调学术的基础性，又兼顾应用的广泛性；既侧重让学生掌握基本的理论知识、专业术语和专业表达方式，又考虑到教材和管理实践的紧密结合，有助于学生形成专业的思维能力，培养实际的管理技能。

● 体系经过精心组织。本套教材在体系架构上充分考虑到当前我国在本科教育阶段推广双语教学的进度安排，首先针对那些课程内容国际化程度较高的学科进行双语教材开发，在其专业模块内精心选择各专业教材。这种安排既有利于我国教师摸索双语教学的经验，使得双语教学贴近现实教学的需要；也有利于我们收集关于双语教学教材的建议，更好地推出后续的双语教材及教辅材料。

● 篇幅合理，价格相对较低。为适应国内双语教学内容和课时上的实际需要，本套教材进行了一定的删减和改编，使总体篇幅更为合理；而采取低定价，则充分考虑到了学生实际的购买能力，从而使本套教材得以真正走近广大读者。

● 提供强大的教学支持。依托国际大出版公司的力量，本套教材为教师提供了配套的教辅材料，如教师手册、PowerPoint 讲义、试题库等，并配有内容极为丰富的网络资源，从而使教学更为便利。

本套教材是在双语教学教材出版方面的一种尝试。我们在选书、改编及出版的过程中得到了国内许多高校的专家、教师的支持和指导，在此深表谢意。同时，为使后续推出的教材更适于教学，我们也真诚地期待广大读者提出宝贵的意见和建议。需要说明的是，尽管我们在改编的过程中已加以注意，但由于各教材的作者所处的政治、经济和文化背景不同，书中内容仍可能有不妥之处，望读者在阅读时注意比较和甄别。

徐二明

中国人民大学商学院

## Preface

This twelfth edition of *Statistics for Business and Economics* is an introductory text emphasizing inference, with extensive coverage of data collection and analysis as needed to evaluate the reported results of statistical studies and make good decisions. As in earlier editions, the text stresses the development of statistical thinking, the assessment of credibility, and the value of the inferences made from data, both by those who consume and those who produce them. It assumes a mathematical background of basic algebra.

The text incorporates the following features, developed from the American Statistical Association (ASA)-sponsored conferences on *Making Statistics More Effective in Schools of Business* (MSMESB) and the ASA's Guidelines for Assessment and Instruction in Statistics Education (GAISE) Project:

- Emphasize statistical literacy and develop statistical thinking
- Use real data in applications
- Use technology for developing conceptual understanding and analyzing data
- Foster active learning in the classroom
- Stress conceptual understanding rather than mere knowledge of procedures
- Emphasize intuitive concepts of probability

---

## New in the Twelfth Edition

- **New Statistics in Action Cases.** Four of the 14 Statistics in Action cases are new, each based on real data from a recent business study.
- **Continued Emphasis on Ethics.** Where appropriate, boxes have been added emphasizing the importance of ethical behavior when collecting, analyzing, and interpreting data with statistics.

---

## Content-Specific Changes to This Edition

- **Chapter 1 (Statistics, Data, and Statistical Thinking).** Material on all basic sampling concepts (e.g., random sampling and sample survey designs) has been streamlined and moved to Section 1.6 (Collecting Data: Sampling and Related Issues).
- **Chapter 2 (Methods for Describing Sets of Data).** The section on summation notation has been moved to the appendix (Appendix A). Also, recent examples of misleading graphics have been added to Section 2.10 (Distorting the Truth with Descriptive Techniques).
- **Chapter 4 (Random Variables and Probability Distributions).** Use of technology for computing probabilities of random variables with known probability distributions (e.g., binomial, Poisson, normal, and exponential distributions) has been incorporated into the relevant sections of this chapter. Also, the section on approximating a binomial distribution with a normal distribution has been incorporated into Section 4.6 (The Normal Distribution).
- **Chapter 5 (Sampling Distributions).** Material on the sampling distribution of the sample mean (originally in Part III of Chapter 4) has been moved to create this new chapter. Also, two new sections have been added, Section 5.2 (Properties of Sampling Distributions: Unbiasedness and Minimum Variance) and Section 5.4 (The Sampling Distribution of the Sample Proportion).

- **Chapter 6 (Inferences Based on a Single Sample: Estimation with Confidence Intervals).** An optional section (Section 6.7) on estimating a population variance has been added.
- **Chapter 7 (Inferences Based on a Single Sample: Tests of Hypotheses).** The section on  $p$ -values in hypothesis testing (Section 7.3) has been moved up to emphasize the importance of their use in business-related studies. Throughout the remainder of the text, conclusions from a test of hypothesis are based on  $p$ -values.
- **Chapter 10 (Categorical Data Analysis).** A subsection on contingency tables with fixed marginals has been added to Section 10.3.

## Hallmark Strengths

---

We have maintained the pedagogical features of *Statistics for Business and Economics* that we believe make it unique among introductory business statistics texts. These features, which assist the student in achieving an overview of statistics and an understanding of its relevance in both the business world and everyday life, are as follows:

- **Use of Examples as a Teaching Device** Almost all new ideas are introduced and illustrated by data-based applications and examples. We believe that students better understand definitions, generalizations, and theoretical concepts *after* seeing an application. All examples have three components: (1) Problem, (2) Solution, and (3) Look Back (or Look Ahead). This step-by-step process provides students with a defined structure by which to approach problems and enhances their problem-solving skills. The Look Back/Look Ahead feature often gives helpful hints to solving the problem and/or provides a further reflection or insight into the concept or procedure that is covered.
- **Statistics in Action Cases** Each chapter begins with a case study based on an actual contemporary, controversial, or high-profile issue in business. Relevant research questions and data from the study are presented and the proper analysis demonstrated in short *Statistics in Action Revisited* sections throughout the chapter. These motivate students to critically evaluate the findings and think through the statistical issues involved.
- **Making Business Decisions Cases** Seven extensive real-world business problem-solving cases, with real data and assignments for the student, serve as a good capstone and review of the material that precedes it. Typically, these cases follow two or three chapters and require the student to apply the methods presented in these chapters.
- **Biographies** Brief descriptions of famous statisticians and their achievements are presented in side boxes. With these profiles, students will develop an appreciation of the statistician's efforts and the discipline of statistics as a whole.
- **Exploring Data with Statistical Software** Each statistical analysis method presented is demonstrated using output from Excel/XLSTAT, SPSS, Minitab, and the TI-84 graphing calculator. Students are exposed early and often to computer printouts they will encounter in today's high-tech business world.

## Flexibility in Coverage

---

The text is written to allow the instructor flexibility in coverage of topics. Suggestions for two topics, probability and regression, are given below.

- **Probability and Counting Rules** One of the most troublesome aspects of an introductory statistics course is the study of probability. Probability poses a challenge for instructors because they must decide on the level of presentation, and students find it

a difficult subject to comprehend. We believe that one cause for these problems is the mixture of probability and counting rules that occurs in most introductory texts. Consequently, we have included the counting rules (with examples) in an appendix (Appendix B) rather than in the body of Chapter 3. Thus, the instructor can control the level of coverage of probability covered.

- ▣ **Multiple Regression and Model Building** This topic represents one of the most useful statistical tools for the solution of applied problems. Although an entire text could be devoted to regression modeling, we believe that we have presented coverage that is understandable, usable, and much more comprehensive than the presentations in other introductory statistics texts. We devote two full chapters to discussing the major types of inferences that can be derived from a regression analysis, showing how these results appear in the output from statistical software, and, most important, selecting multiple regression models to be used in an analysis. Thus, the instructor has the choice of a one-chapter coverage of simple linear regression (Chapter 11), a two-chapter treatment of simple and multiple regression (excluding the sections on model building in Chapter 12), or complete coverage of regression analysis, including model building and regression diagnostics. This extensive coverage of such useful statistical tools will provide added evidence to the student of the relevance of statistics to real-world problems.
- ▣ **Role of Calculus in Footnotes** Although the text is designed for students with a noncalculus background, footnotes explain the role of calculus in various derivations. Footnotes are also used to inform the student about some of the theory underlying certain methods of analysis. These footnotes allow additional flexibility in the mathematical and theoretical levels at which the material is presented.



# 简明目录

第1章 统计、数据和统计思维.....	( 1 )
第2章 数据集的描述方法.....	( 26 )
第3章 概 率.....	( 82 )
第4章 随机变量与概率分布.....	( 115 )
第5章 抽样分布.....	( 165 )
第6章 基于单样本的统计推断：置信区间的估计.....	( 188 )
第7章 基于单样本的统计推断：假设检验.....	( 219 )
第8章 基于两样本的统计推断：置信区间和假设检验.....	( 258 )
第9章 试验设计和方差分析.....	( 294 )
第10章 分类数据的分析.....	( 341 )
第11章 简单线性回归.....	( 363 )
第12章 多元线性回归和模型建立.....	( 401 )

# Contents

Preface

i

## 1

### Statistics, Data, and Statistical Thinking

1

1.1	The Science of Statistics	3
1.2	Types of Statistical Applications in Business	3
1.3	Fundamental Elements of Statistics	5
1.4	Processes (Optional)	10
1.5	Types of Data	12
1.6	Collecting Data: Sampling and Related Issues	14
1.7	Critical Thinking with Statistics	20
	<b>STATISTICS in ACTION: A 20/20 View of Surveys: Fact or Fiction?</b>	1
	<b>ACTIVITY 1.1: <i>Keep the Change</i>: Collecting Data</b>	24
	<b>ACTIVITY 1.2: Identifying Misleading Statistics</b>	25

## 2

### Methods for Describing Sets of Data

26

2.1	Describing Qualitative Data	28
2.2	Graphical Methods for Describing Quantitative Data	37
2.3	Numerical Measures of Central Tendency	44
2.4	Numerical Measures of Variability	50
2.5	Using the Mean and Standard Deviation to Describe Data	54
2.6	Numerical Measures of Relative Standing	59
2.7	Methods for Detecting Outliers: Box Plots and z-Scores	61
2.8	Graphing Bivariate Relationships (Optional)	68
2.9	The Time Series Plot (Optional)	71
2.10	Distorting the Truth with Descriptive Techniques	73
	<b>STATISTICS in ACTION: Can Money Buy Love?</b>	26
	<b>ACTIVITY 2.1: Real Estate Sales</b>	79
	<b>MAKING BUSINESS DECISIONS: The Kentucky Milk Case—Part 1 (Covers Chapters 1 and 2)</b>	80

## 3

### Probability

82

3.1	Events, Sample Spaces, and Probability	84
3.2	Unions and Intersections	93
3.3	Complementary Events	96
3.4	The Additive Rule and Mutually Exclusive Events	98
3.5	Conditional Probability	101
3.6	The Multiplicative Rule and Independent Events	104
3.7	Bayes's Rule	110

<b>STATISTICS in ACTION:</b> Lotto Buster!	82
<b>ACTIVITY 3.1:</b> Exit Polls: Conditional Probability	114
<b>ACTIVITY 3.2:</b> Keep the Change: Independent Events	114

## 4 Random Variables and Probability Distributions 115

4.1 Two Types of Random Variables	116
<b>PART I: DISCRETE RANDOM VARIABLES</b>	<b>118</b>
4.2 Probability Distributions for Discrete Random Variables	118
4.3 The Binomial Distribution	125
4.4 Other Discrete Distributions: Poisson and Hypergeometric	135
<b>PART II: CONTINUOUS RANDOM VARIABLES</b>	<b>140</b>
4.5 Probability Distributions for Continuous Random Variables	140
4.6 The Normal Distribution	141
4.7 Descriptive Methods for Assessing Normality	154
4.8 Other Continuous Distributions: Uniform and Exponential	156
<b>STATISTICS in ACTION:</b> Probability in a Reverse Cocaine Sting: Was Cocaine Really Sold?	115
<b>ACTIVITY 4.1:</b> Warehouse Club Memberships: Exploring a Binomial Random Variable	163
<b>ACTIVITY 4.2:</b> Identifying the Type of Probability Distribution	164

## 5 Sampling Distributions 165

5.1 The Concept of a Sampling Distribution	167
5.2 Properties of Sampling Distributions: Unbiasedness and Minimum Variance	172
5.3 The Sampling Distribution of the Sample Mean and the Central Limit Theorem	175
5.4 The Sampling Distribution of the Sample Proportion	181
<b>STATISTICS in ACTION:</b> The Insomnia Pill: Is It Effective?	165
<b>ACTIVITY 5.1:</b> Simulating a Sampling Distribution—Cell Phone Usage	184
<b>MAKING BUSINESS DECISIONS:</b> The Furniture Fire Case (Covers Chapters 3–5)	186

## 6 Inferences Based on a Single Sample: Estimation with Confidence Intervals 188

6.1 Identifying and Estimating the Target Parameter	190
6.2 Confidence Interval for a Population Mean: Normal ( $z$ ) Statistic	191
6.3 Confidence Interval for a Population Mean: Student's $t$ -Statistic	196
6.4 Large-Sample Confidence Interval for a Population Proportion	202
6.5 Determining the Sample Size	207
6.6 Finite Population Correction for Simple Random Sampling (Optional)	211
6.7 Confidence Interval for a Population Variance (Optional)	213
<b>STATISTICS in ACTION:</b> Medicare Fraud Investigations	188

<b>ACTIVITY 6.1: Conducting a Pilot Study</b>	<b>218</b>
---	------------

---

## **7** Inferences Based on a Single Sample: Tests of Hypotheses **219**

<b>7.1</b>	The Elements of a Test of Hypothesis	<b>220</b>
<b>7.2</b>	Formulating Hypotheses and Setting Up the Rejection Region	<b>225</b>
<b>7.3</b>	Observed Significance Levels: $p$ -Values	<b>229</b>
<b>7.4</b>	Test of Hypothesis about a Population Mean: Normal ( $z$ ) Statistic	<b>233</b>
<b>7.5</b>	Test of Hypothesis about a Population Mean: Student's $t$ -Statistic	<b>237</b>
<b>7.6</b>	Large-Sample Test of Hypothesis about a Population Proportion	<b>241</b>
<b>7.7</b>	Test of Hypothesis about a Population Variance	<b>245</b>
<b>7.8</b>	Calculating Type II Error Probabilities: More about $\beta$ (Optional)	<b>248</b>
	<b>STATISTICS in ACTION: Diary of a Kleenex® User—How Many Tissues in a Box?</b>	<b>219</b>
	<b>ACTIVITY 7.1: Challenging a Company's Claim: Tests of Hypotheses</b>	<b>256</b>
	<b>ACTIVITY 7.2: Keep the Change: Tests of Hypotheses</b>	<b>257</b>

---

## **8** Inferences Based on Two Samples: Confidence Intervals and Tests of Hypotheses **258**

<b>8.1</b>	Identifying the Target Parameter	<b>259</b>
<b>8.2</b>	Comparing Two Population Means: Independent Sampling	<b>260</b>
<b>8.3</b>	Comparing Two Population Means: Paired Difference Experiments	<b>271</b>
<b>8.4</b>	Comparing Two Population Proportions: Independent Sampling	<b>277</b>
<b>8.5</b>	Determining the Required Sample Size	<b>282</b>
<b>8.6</b>	Comparing Two Population Variances: Independent Sampling	<b>284</b>
	<b>STATISTICS in ACTION: Zixlt Corp. v. Visa USA Inc.—A Libel Case</b>	<b>258</b>
	<b>ACTIVITY 8.1: Box Office Receipts: Comparing Population Means</b>	<b>292</b>
	<b>ACTIVITY 8.2: Keep the Change: Inferences Based on Two Samples</b>	<b>292</b>
	<b>MAKING BUSINESS DECISIONS: The Kentucky Milk Case—Part II (Covers Chapters 6–8)</b>	<b>293</b>

---

## **9** Design of Experiments and Analysis of Variance **294**

<b>9.1</b>	Elements of a Designed Experiment	<b>295</b>
<b>9.2</b>	The Completely Randomized Design: Single Factor	<b>300</b>
<b>9.3</b>	Multiple Comparisons of Means	<b>313</b>
<b>9.4</b>	The Randomized Block Design	<b>318</b>
<b>9.5</b>	Factorial Experiments: Two Factors	<b>327</b>
	<b>STATISTICS in ACTION: Pollutants at a Housing Development—A Case of Mishandling Small Samples</b>	<b>294</b>
	<b>ACTIVITY 9.1: Designed vs. Observational Experiments</b>	<b>339</b>



<b>10</b>	<b>Categorical Data Analysis</b>	<b>341</b>
	<b>10.1</b> Categorical Data and the Multinomial Experiment	342
	<b>10.2</b> Testing Category Probabilities: One-Way Table	344
	<b>10.3</b> Testing Category Probabilities: Two-Way (Contingency) Table	347
	<b>10.4</b> A Word of Caution about Chi-Square Tests	357
	<b>STATISTICS in ACTION:</b> The Case of the Ghoulish Transplant Tissue—Who Is Responsible for Paying Damages?	341
	<b>ACTIVITY 10.1:</b> Binomial vs. Multinomial Experiments	359
	<b>ACTIVITY 10.2:</b> Contingency Tables	359
	<b>MAKING BUSINESS DECISIONS:</b> Discrimination in the Workplace (Covers Chapters 9 and 10)	360
<hr/>		
<b>11</b>	<b>Simple Linear Regression</b>	<b>363</b>
	<b>11.1</b> Probabilistic Models	365
	<b>11.2</b> Fitting the Model: The Least Squares Approach	367
	<b>11.3</b> Model Assumptions	375
	<b>11.4</b> Assessing the Utility of the Model: Making Inferences about the Slope $\beta_1$	378
	<b>11.5</b> The Coefficients of Correlation and Determination	382
	<b>11.6</b> Using the Model for Estimation and Prediction	389
	<b>11.7</b> A Complete Example	394
	<b>STATISTICS in ACTION:</b> Legal Advertising—Does It Pay?	363
	<b>ACTIVITY 11.1:</b> Applying Simple Linear Regression to Your Favorite Data	400
<hr/>		
<b>12</b>	<b>Multiple Regression and Model Building</b>	<b>401</b>
	<b>12.1</b> Multiple Regression Models	402
	<b>PART I: FIRST-ORDER MODELS WITH QUANTITATIVE INDEPENDENT VARIABLES</b>	404
	<b>12.2</b> Estimating and Making Inferences about the $\beta$ Parameters	404
	<b>12.3</b> Evaluating Overall Model Utility	410
	<b>12.4</b> Using the Model for Estimation and Prediction	414
	<b>PART II: MODEL BUILDING IN MULTIPLE REGRESSION</b>	418
	<b>12.5</b> Interaction Models	418
	<b>12.6</b> Quadratic and Other Higher-Order Models	422
	<b>12.7</b> Qualitative (Dummy) Variable Models	427
	<b>12.8</b> Models with Both Quantitative and Qualitative Variables	431
	<b>12.9</b> Comparing Nested Models	437
	<b>12.10</b> Stepwise Regression	441
	<b>PART III: MULTIPLE REGRESSION DIAGNOSTICS</b>	447
	<b>12.11</b> Residual Analysis: Checking the Regression Assumptions	447
	<b>12.12</b> Some Pitfalls: Estimability, Multicollinearity, and Extrapolation	461
	<b>STATISTICS in ACTION:</b> Bid Rigging in the Highway Construction Industry	401
	<b>ACTIVITY 12.1:</b> <i>Insurance Premiums:</i> Collecting Data for Several Variables	468
	<b>ACTIVITY 12.2:</b> Collecting Data and Fitting a Multiple Regression Model	468

<b>MAKING BUSINESS DECISIONS: The Condo Sales Case (Covers Chapters 11 and 12)</b>	<b>469</b>
--	------------

---

<b>Appendix A: Summation Notation</b>	<b>471</b>
<b>Appendix B: Basic Counting Rules</b>	<b>473</b>
<b>Appendix C: Calculation Formulas for Analysis of Variance</b>	<b>477</b>
<b>Appendix D: Tables</b>	<b>483</b>

# 1



## CONTENTS

- 1.1 The Science of Statistics
- 1.2 Types of Statistical Applications in Business
- 1.3 Fundamental Elements of Statistics
- 1.4 Processes\*
- 1.5 Types of Data
- 1.6 Collecting Data: Sampling and Related Issues
- 1.7 Critical Thinking with Statistics

## Statistics, Data, and Statistical Thinking

### STATISTICS in ACTION

### A 20/20 View of Surveys: Fact or Fiction?

*“Did you ever notice that, no matter where you stand on popular issues of the day, you can always find statistics or surveys to back up your point of view—whether to take vitamins, whether daycare harms kids, or what foods can hurt you or save you? There is an endless flow of information to help you make decisions, but is this information accurate, unbiased? John Stossel decided to check that out, and you may be surprised to learn if the picture you’re getting doesn’t seem quite right, maybe it isn’t.”*

Barbara Walters gave this introduction to a segment of the popular prime-time ABC television program *20/20*. The story was titled “Fact or Fiction?—Exposés of So-Called Surveys.” One of the surveys investigated by ABC correspondent John Stossel compared the discipline problems experienced by teachers in the 1940s and those experienced today. The results: In the 1940s, teachers worried most about students talking in class, chewing gum, and running in the halls. Today, they worry most about being assaulted! This information was highly publicized in the print media—in daily newspapers, weekly magazines, gossip columns, the *Congressional Quarterly*, and the *Wall Street Journal*, among others—and referenced in speeches by a variety of public figures, including former first lady Barbara Bush and former Education Secretary William Bennett.

“Hearing this made me yearn for the old days when life was so much simpler and gentler, but was life that simple then?” asks Stossel. “Wasn’t there juvenile delinquency [in the 1940s]? Is the survey true?” With the help of a Yale School of Management professor, Stossel found the original source of the teacher survey—Texas oilman T. Colin Davis—and discovered it wasn’t a survey at all! Davis had simply identified certain disciplinary problems encountered by teachers in a conservative newsletter—a list he admitted was not obtained from a statistical survey, but

### Where We’re Going

- Introduce the field of statistics (1.1)
- Demonstrate how statistics applies to business (1.2)
- Introduce the language of statistics and the key elements of any statistical problem (1.3)
- Differentiate between population and sample data (1.3)
- Differentiate between descriptive and inferential statistics (1.3)
- Introduce the key elements of a process (1.4)
- Identify the different types of data and data-collection methods (1.5–1.6)
- Discover how critical thinking through statistics can help improve our quantitative literacy (1.7)

**STATISTICS  
in ACTION  
CONTINUED**

from Davis's personal knowledge of the problems in the 1940s. ("I was in school then") and his understanding of the problems today ("I read the papers").

Stossel's critical thinking about the teacher "survey" led to the discovery of research that is misleading at best and unethical at worst. Several more misleading (and possibly unethical) surveys, conducted by businesses or special interest groups with specific objectives in mind, were presented on the ABC program. These are listed below. Two other studies are also discussed.

The *20/20* segment ended with an interview of Cynthia Crossen, author of *Tainted Truth: The Manipulation of Fact in America*, an exposé of misleading and biased surveys. Crossen warns, "If everybody is misusing numbers and scaring us with numbers to get us to do something, however good [that something] is, we've lost the power of numbers. Now, we know certain things from research. For example, we know that smoking cigarettes is hard on your lungs and heart, and because we know that, many people's lives have been extended or saved. We don't want to lose the power of information to help us make decisions, and that's what I worry about."

Reported Information (Source)	Actual Study Information
1. Eating oat bran is a cheap and easy way to reduce your cholesterol. (Quaker Oats)	Diet must consist of nothing but oat bran to reduce your cholesterol count.
2. 150,000 women a year die from anorexia. (Feminist group)	Approximately 1,000 women a year die from problems that were likely caused by anorexia.
3. Domestic violence causes more birth defects than all medical issues combined. (March of Dimes)	No study—false report.
4. Only 29% of high school girls are happy with themselves, compared to 66% of elementary school girls. (American Association of University Women)	Of 3,000 high school girls, 29% responded, "Always true" to the statement "I am happy the way I am." Most answered, "Sort of true" and "Sometimes true."
5. One in four American children under age 12 is hungry or at risk of hunger. (Food Research and Action Center)	Based on responses to questions: "Do you ever cut the size of meals?" "Do you ever eat less than you feel you should?" "Did you ever rely on limited numbers of foods to feed your children because you were running out of money to buy food for a meal?"
6. There is a strong correlation between a CEO's golf handicap and the company's stock performance: The lower the CEO's handicap (i.e., the better the golfer), the better the stock performs. ( <i>New York Times</i> , May 31, 1998)	Survey sent to CEOs of 300 largest U.S. companies; only 51 revealed their golf handicaps. Data for several top-ranking CEOs were excluded from the analysis.
7. If the federal government's health reform act is passed, 30% of employers are predicted to "definitely" or "probably" stop offering health coverage. (McKinsey & Company Survey, Feb. 2011)	Online survey of 1,329 private-sector employers in the United States. Respondents were asked leading questions that made it logical to stop offering health insurance.

In the following *Statistics in Action Revisited* sections, we discuss several key statistical concepts covered in this chapter that are relevant to misleading surveys like those exposed in the *20/20* program.

**STATISTICS in ACTION REVISITED**

- Identifying the population, sample, and inference
- Identifying the data-collection method and data type
- Critically assessing the ethics of a statistical study



## 1.1 The Science of Statistics

What does *statistics* mean to you? Does it bring to mind batting averages? Gallup polls, unemployment figures, or numerical distortions of facts (lying with statistics!)? Or is it simply a college requirement you have to complete? We hope to persuade you that statistics is a meaningful, useful science whose broad scope of applications to business, government, and the physical and social sciences is almost limitless. We also want to show that statistics can lie only when they are misapplied. Finally, we wish to demonstrate the key role statistics play in critical thinking—whether in the classroom, on the job, or in everyday life. Our objective is to leave you with the impression that the time you spend studying this subject will repay you in many ways.

Although the term can be defined in many ways, a broad definition of *statistics* is the science of collecting, classifying, analyzing, and interpreting information. Thus, a statistician isn't just someone who calculates batting averages at baseball games or tabulates the results of a Gallup poll. Professional statisticians are trained in *statistical science*—that is, they are trained in collecting information in the form of **data**, evaluating it, and drawing conclusions from it. Furthermore, statisticians determine what information is relevant in a given problem and whether the conclusions drawn from a study are to be trusted.

**Statistics** is the science of data. It involves collecting, classifying, summarizing, organizing, analyzing, and interpreting numerical and categorical information.

In the next section, you'll see several real-life examples of statistical applications in business and government that involve making decisions and drawing conclusions.

## 1.2 Types of Statistical Applications in Business

### BIOGRAPHY

#### FLORENCE NIGHTINGALE (1820–1910)

##### *The Passionate Statistician*

In Victorian England, the “Lady of the Lamp” had a mission to improve the squalid field hospital conditions of the British army during the Crimean War. Today, most historians consider Florence Nightingale to be the founder of the nursing profession. To convince members of the British Parliament of the need for supplying nursing and medical care to soldiers in the field, Nightingale compiled massive amounts of data from the army files. Through a remarkable series of graphs (which included the first “pie chart”), she demonstrated that most of the deaths in the war were due to illnesses contracted outside the battlefield or long after battle action from wounds that went untreated. Florence Nightingale's compassion and self-sacrificing nature, coupled with her ability to collect, arrange, and present large amounts of data, led some to call her the “Passionate Statistician.”

Statistics means “numerical descriptions” to most people. Monthly unemployment figures, the failure rate of startup companies, and the proportion of female executives in a particular industry all represent statistical descriptions of large sets of data collected on some phenomenon. Often the data are selected from some larger set of data whose characteristics we wish to estimate. We call this selection process *sampling*. For example, you might collect the ages of a sample of customers of an online DVD movie rental company to estimate the average age of *all* customers of the company. Then you could use your estimate to target the firm's advertisements to the appropriate age group. Notice that statistics involves two different processes: (1) describing sets of data and (2) drawing conclusions (making estimates, decisions, predictions, etc.) about the sets of data based on sampling. So, the applications of statistics can be divided into two broad areas: *descriptive statistics* and *inferential statistics*.

**Descriptive statistics** utilizes numerical and graphical methods to explore data, i.e., to look for patterns in a data set, to summarize the information revealed in a data set, and to present the information in a convenient form.

**Inferential statistics** utilizes sample data to make estimates, decisions, predictions, or other generalizations about a larger set of data.

Although we'll discuss both descriptive and inferential statistics the primary theme of the text is **inference**.

Let's begin by examining some business studies that illustrate applications of statistics.

**Study 1.1 “Best-Selling Girl Scout Cookies”** ([www.girlscouts.org](http://www.girlscouts.org)): Since 1917, the Girl Scouts of America have been selling boxes of cookies. Currently, there are eight varieties for