

# Business Statistics for Competitive Advantage with Excel 2019 and JMP

Cynthia Fraser

# Business Statistics for Competitive Advantage with Excel 2019 and JMP

Basics, Model Building, Simulation and Cases

Cynthia Fraser  
McIntire School of Commerce  
University of Virginia  
Charlottesville, VA, USA

ISBN 978-3-030-20373-3      ISBN 978-3-030-20374-0 (eBook)  
<https://doi.org/10.1007/978-3-030-20374-0>

© Springer Nature Switzerland AG 2019

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Table of Contents

<b>Preface</b> .....	<b>xi</b>
<b>Chapter 1 Statistics for Decision Making and Competitive Advantage</b> .....	<b>1</b>
1.1 Statistical Competences Translate into Competitive Advantages .....	1
1.2 The Path Toward Statistical Competence and Competitive Advantage.....	2
1.3 Use Excel for Competitive Advantage.....	2
1.4 Statistical Competence Is Powerful and Yours .....	3
<b>Chapter 2 Describing Your Data</b> .....	<b>5</b>
2.1 Describe Data with Summary Statistics and Histograms .....	5
2.2 Round Descriptive Statistics .....	7
2.3 Share the Story That Your Graphics Illustrate .....	7
2.4 Data Is Measured with Quantitative or Categorical Scales .....	8
2.5 Central Tendency, Dispersion and Skewness Describe Data.....	9
2.6 Describe Categorical Variables Graphically .....	9
2.7 PivotTables Inform by Revealing Segment Distribution Differences.....	10
2.8 Descriptive Statistics Depend on the Data and Rely on Your Packaging .....	11
Excel 2.1 Produce Descriptive Statistics.....	13
Excel 2.2 Produce a Histogram of the Distribution.....	14
Excel 2.3 Plot a Cumulative Distribution.....	19
Excel 2.4 Use a PivotTable to Sort by Industry .....	21
Excel Shortcuts Used in Chapter 2.....	24
Significant Digits Guidelines .....	27
Lab 2-1 Description: Compensation of Best Paid CEOs.....	29
Assignment 2-1 Shortcut Challenge.....	31
Case 2-1 Where Are the Billionaires?.....	33
<b>Chapter 3 Hypothesis Tests and Confidence Intervals to Infer Population Characteristics and Differences</b> .....	<b>35</b>
3.1 Continuous Data Are Sometimes Normal .....	35
3.2 The Empirical Rule Simplifies Description .....	36
3.3 Assess the Difference Between Alternate Scenarios or Pairs .....	36
3.4 Sample Means Are Random Variables .....	39
3.5 Confidence Intervals Estimate the Population Mean .....	42
3.6 Determine Whether Two Segments Differ with Student t .....	43
3.7 Estimate the Extent of Difference Between Two Segments .....	47
3.8 Estimate a Population Proportion from a Sample Proportion .....	48
3.9 Conditions for Assuming Approximate Normality .....	49
3.10 Conservative Confidence Intervals for a Proportion.....	49
3.11 Inference from Sample to Population.....	50
Excel 3.1 Test the Mean Difference in Between Alternate Pairs with a Paired t Test.....	53
Excel 3.2 Construct a Confidence Interval for the Difference Between Pairs .....	53

Excel 3.3	Test the Difference Between Two Segment Means with a Two Sample t Test.....	57
Excel 3.4	Construct a Confidence Interval for the Difference Between Two Segments.....	57
	Lab 3-1 Inference.....	61
	Assignment 3-1 McLattes.....	63
	Assignment 3-2 Inference: Dell Smartphone Plans.....	63
	Assignment 3-3 The Hilton Difference.....	64
	Assignment 3-4 U.S. Actions to Address Climate Change.....	65
	Case 3-1 Polaski Vodka: Can a Polish Vodka Stand Up to the Russians?.....	67
<b>Chapter 4</b>	<b>Simulation to Infer Future Performance Levels Given Assumptions.....</b>	<b>69</b>
4.1	Specify Assumptions Concerning Future Performance Drivers.....	69
4.2	Compare Best and Worst Case Performance Outcomes.....	72
4.3	Spread and Shape Assumptions Influence Possible Outcomes.....	74
4.4	Monte Carlo Simulation of the Distribution of Performance Outcomes.....	75
4.5	When Results Are Unbelievable or Too Uncertain, Adjust Assumptions.....	79
4.6	Monte Carlo Simulation Reveals Possible Outcomes Given Assumptions.....	81
Excel 4.1	Set Up a Spreadsheet to Link Simulated Performance Components.....	83
	Lab 4-1 Inference: Bottled Water Revenues.....	89
	Case 4-1 Inference: Dell Android Smartphone Plans.....	91
	Case 4-2 Can Whole Foods Hold On?.....	92
<b>Chapter 5</b>	<b>Simple Regression.....</b>	<b>95</b>
5.1	The Simple Linear Regression Equation Describes the Line Relating an Independent Variable to Performance.....	96
5.2	Hide the Two Most Recent Datapoints to Validate a Time Series Model.....	96
5.3	Test and Infer the Slope.....	100
5.4	The Regression Standard Error Reflects Model Precision.....	102
5.5	Prediction Intervals Enable Validation.....	104
5.6	<i>Rsquare</i> Summarizes Strength of the Hypothesized Linear Relationship and <i>F</i> Tests Its Significance.....	105
5.7	Assess Residuals to Learn Whether Assumptions Are Met.....	108
5.8	Recalibrate to Update a Valid Model.....	111
5.9	Present Regression Results in Concise Format.....	113
5.10	Assumptions We Make When We Use Linear Regression.....	113
5.11	Correlation Reflects Linear Association.....	114
5.12	Correlation Coefficients Are Key Components of Regression Slopes.....	116
5.13	Correlation Complements Regression.....	117
5.14	Linear Regression Is Doubly Useful.....	118
Excel 5.1	Build a Simple Linear Regression Model.....	119
Excel 5.2	Assess Residuals.....	120
Excel 5.3	Construct Prediction Intervals to Validate.....	122
Excel 5.4	Recalibrate and Present Fit and Forecast in a Scatterplot.....	125
	Lab 5-1 Forecast 2020 Concha y Toro Exports to the U.S. ....	129
	Assignment 5-1 Forecast Concha y Toro Exports to Europe and Asia.....	131

<b>Chapter 6</b>	<b>Finance Application: Portfolio Analysis with a Market Index as a Leading Indicator in Simple Linear Regression .....</b>	<b>135</b>
6.1	Rates of Return Reflect Expected Growth of Stock Prices .....	135
6.2	Investors Trade Off Risk and Return .....	137
6.3	Beta Measures Risk .....	137
6.4	A Portfolio Expected Return, Risk and Beta Are Weighted Averages of Individual Stocks .....	140
6.5	Better Portfolios Define the Efficient Frontier.....	141
	MEMO Re: Recommended Portfolio Is Diversified .....	143
6.6	Portfolio Risk Depends on Correlations with the Market and Stock Variability .....	143
Excel 6.1	Estimate Portfolio Expected Rate of Return and Risk .....	145
Excel 6.2	Plot Return by Risk to Identify Dominant Portfolios and the Efficient Frontier .....	146
	Lab 6-1 Portfolio Risk and Return .....	151
	Assignment 6-1 Portfolio Risk and Return .....	153
<b>Chapter 7</b>	<b>Indicator Variables .....</b>	<b>155</b>
7.1	Indicators Modify the Intercept to Account for Segment Differences .....	155
7.2	Indicators Modify the Intercept to Account for Shifts or Shocks.....	158
7.3	Indicators Enhance Both Cross Sectional and Time Series Regression Models.....	162
Excel 7.1	Build a Regression Model to Compare Segments Using Indicators .....	164
Excel 7.2	Plot Segment Predictions .....	165
	JMP 7 Run Multiple Regression and Find Individual Prediction Intervals.....	172
	Lab 7-1 Harley-Davidson Revenues .....	179
<b>Chapter 8</b>	<b>Presenting Statistical Analysis Results to Management.....</b>	<b>183</b>
8.1	Use PowerPoints to Present Statistical Results for Competitive Advantage.....	183
8.2	Write Memos That Encourage Your Audience to Read and Use Results.....	190
	MEMO Re: Worldwide Exports Forecast to Grow Modestly Through 2016 .....	192
<b>Chapter 9</b>	<b>Nonlinear Regression Models .....</b>	<b>195</b>
9.1	Consider a Nonlinear Model When Response Is Not Constant .....	195
9.2	Skewness Signals Nonlinear Response .....	195
9.3	Rescaling $y$ Builds in Interactions .....	199
9.4	When to Rescale.....	200
9.5	Gains from Nonlinear Rescaling Are Significant.....	207
9.6	Nonlinear Models Offer the Promise of Better Fit and Better Behavior.....	208
Excel 9.1	Rescale to Build and Fit Nonlinear Regression Models with Linear Regression .....	209
Excel 9.2	Forecast White VPBs with Natural Logarithms.....	210
	JMP 9.1 Find Individual Prediction Interval Bounds with JMP .....	217
Excel 9.3	Illustrate the Model Fit and Forecast.....	220
Excel 9.4	Forecast Black VPBs with Cubes.....	222
	Lab 9-1 World Wine Consumption by Global Region.....	229
	Case 9-1 Forecasting Wine Consumption in Europe .....	231
	Case 9-2 Markets for Vastly Better Roots Soil Additive .....	232
	Assignment 9-3 Billionaires in 2020.....	235

<b>Chapter 10</b>	<b>Logit Regression for Bounded Dependent Variables .....</b>	<b>237</b>
10.1	Rescaling Probabilities or Shares to Odds Improves Model Validity .....	237
10.2	Logit Models Provide the Means to Build Valid Models of Shares and Proportions .....	242
Excel 10.1	Regression of a Limited Dependent Variable Using Logits.....	243
	Lab 10-1 Explaining and Forecasting International Air Travel Load Factor .....	249
	Assignment 10-1 Big Drug Co Scripts.....	251
	Assignment 10-2 Forecasting Hotel Occupancy Rates .....	252
<b>Chapter 11</b>	<b>Building Multiple Regression Models .....</b>	<b>253</b>
11.1	Explanatory Multiple Regression Models Identify Drivers and Forecast .....	253
11.2	Use Your Logic to Choose Model Components .....	254
11.3	Multicollinear Variables Are Likely When Few Variable Combinations Are Popular in a Sample.....	255
11.4	<i>F</i> Tests the Joint Significance of the Set of Independent Variables.....	256
11.5	Insignificant Parameter Estimates Signal Multicollinearity .....	258
11.6	Combine or Eliminate Collinear Predictors .....	259
11.7	Sensitivity Analysis Quantifies the Marginal Impact of Drivers .....	262
11.8	Decide Whether Insignificant Drivers Matter .....	263
11.9	Model Building Begins with Logic and Considers Multicollinearity .....	264
Excel 11.1	Build and Fit a Multiple Linear Regression Model.....	266
Excel 11.2	Use Sensitivity Analysis to Compare the Marginal Impacts of Drivers.....	270
	Lab 11-1 Fast Food Establishments Around the Globe.....	275
	Lab 11-2 Where the Starbucks Stores Are Around the Globe .....	277
	Case 11-1 What Is Driving Prices in the Laptop Backpack Market? .....	281
	Case 11-2 Costco's Warehouse Location Scheme .....	283
	Case 11-3 Store24 (A): Managing Employee Retention* and Store24 (B): Service Quality and Employee Skills** .....	286
	Assignment 11-1 Identifying Promising Global Markets .....	289
	Assignment 11-2 Promising Global Markets for EVs.....	289
	Case 11-1 Promising Global Markets for Water Purification .....	291
<b>Chapter 12</b>	<b>Model Building and Forecasting with Multicollinear Time Series .....</b>	<b>293</b>
12.1	Time Series Models Include Decision Variables, External Forces, and Leading Indicators .....	296
12.2	Indicators of Economic Prosperity Lead Business Performance .....	297
12.3	Hide the Two Most Recent Datapoints to Validate a Time Series Model .....	298
12.4	Compare Scatterplots to Choose Driver Lags: Visual Inspection .....	298
12.5	Forecast the Recent, Hidden Points to Assess Predictive Validity.....	305
12.6	Add the Most Recent Datapoints to Recalibrate .....	305
12.7	Driver Part Worths Reveal Importances .....	306
12.8	Do Potential Drivers Not in the Model Matter? .....	307
	MEMO Re: Slow, Stable Growth Forecast in Next Ten Quarters .....	308
12.9	Leading Indicator Components Are Powerful Drivers and Often Multicollinear .....	309
Excel 12.1	Build and Fit a Multiple Regression Model with Multicollinear Time Series .....	311
Excel 12.2	Plot Residuals to Identify Unaccounted for Trend, Cycles, or Seasonality and Assess Autocorrelation.....	312
Excel 12.3	Create Potential Driver Lags .....	313

Excel 12.4	Select the Most Promising Driver .....	317
Excel 12.5	Test the Model's Forecasting Validity .....	321
JMP 12.1	Find Individual Prediction Interval Bounds .....	323
Excel 12.6	Recalibrate to Forecast. ....	327
Excel 12.7	Illustrate the Fit and Forecast. ....	328
Excel 12.8	Assess the Impact of Drivers .....	329
Lab 12-1	Identifying Drivers and Forecasting Marriott Revenues.....	331
Lab 12-2	Identifying Drivers and Forecasting EAP Air Traffic .....	332
Assignment 12-1	Identifying Drivers and Forecasting Aluminum Production in China and North America .....	335
Assignment 12-2	Identifying Drivers and Forecasting the Market for Fertilizer in the U.S.....	339
<b>Chapter 13</b>	<b>Association Between Two Categorical Variables: Contingency Analysis with Chi Square.....</b>	<b>341</b>
13.1	When Conditional Probabilities Differ from Joint Probabilities, There Is Evidence of Association.....	341
13.2	Chi Square Tests Association Between Two Categorical Variables.....	343
13.3	Chi Square Is Unreliable If Cell Counts Are Sparse .....	344
13.4	Simpson's Paradox Can Mislead.....	346
MEMO Re.:	Country of Assembly Does Not Affect Older Buyers' Choices.....	351
13.5	Contingency Analysis Is Demanding.....	352
13.6	Contingency Analysis Is Quick, Easy, and Readily Understood .....	352
Excel 13.1	Construct Crosstabulations and Assess Association Between Categorical Variables with PivotTables and PivotCharts.....	353
Excel 13.2	Use Chi Square to Test Association .....	355
Excel 13.3	Conduct Contingency Analysis with Three Categories.....	358
Lab 13-1	Skype Appeal.....	365
Lab 13-2	Identifying the Target Market for Vastly Sustainable Paper .....	366
Case 13-1	Paper Expenditure and Interest in Vastly Sustainable Paper Products.....	371
Case 13-2	Purchase Frequency and Interest in Vastly Sustainable Paper Products .....	372
Case 13-3	Sustainable Toilet Tissue Appeal.....	373
Case 13-4	Generation, Household Size and Interest in Vastly Sustainable Toilet Tissue.....	374
Case 13-5	Tony's GREAT Advertising .....	376
Case 13-6	Hybrid Motivations .....	377
<b>Chapter 14</b>	<b>Conjoint Analysis and Experimental Data .....</b>	<b>379</b>
14.1	Indicators Estimate the Value of Product Attributes.....	379
14.2	Analysis of Variance Offers an Alternative to Regression with Indicators .....	385
14.3	ANOVA in Excel .....	393
14.4	ANOVA from JMP .....	393
14.5	ANOVA and Regression with Indicators Are Substitutes .....	395
Excel 14.1	Use Indicators to Find Part Worths and Attribute Importances .....	397
JMP 14.1	Run ANOVA and Pairwise Comparisons of Factor Levels.....	400
Lab 14-1	Smartphone Design Preferences .....	405



Case 14-1 Background Music to Enhance Ad Message Recall ..... 409  
Case 14-2 Power PowerPoints ..... 411

**Index..... 415**

# Preface

Exceptional managers know that they can create competitive advantages by basing decisions on performance response under alternative scenarios. To create these advantages, managers need to understand how to use statistics to provide information on performance response under alternative scenarios. Statistics are created to make better decisions. Statistics are essential and relevant. Statistics must be easily and quickly produced using widely available software, Excel or JMP. Then results must be translated into general business language and illustrated with compelling graphics to make them understandable and usable by decision makers. This book helps students master this process of using statistics to create competitive advantages as decision makers.

Statistics are essential, relevant, easy to produce, easy to understand, valuable, and a powerful source of competitive advantage.

## The Examples, Assignments, and Cases Used to Illustrate Statistics for Decision Making Come from Business Problems

McIntire Corporate Sponsors and Partners, such as Hilton, Margaritaville, Alcoa, Rolls-Royce, Procter & Gamble, Dell, and Vastly, and the industries that they do business in, provide many realistic examples. Supporting data files feature data from Annual Reports, the World Bank, and online government sources, such as bea.gov. The book also features a number of examples of global business problems, including those from important emerging markets in China, India, and Chile. Students are excited when statistics are used to study real and important business problems. This makes it easy to see how they will use statistics to create competitive advantages in their internships and careers.

## Learning Is Hands on with Excel and Shortcuts

Each type of analysis is introduced with one or more examples. Following is an example of how to create the statistics in Excel or JMP, and what the numbers mean in English. In cases in which Excel does not offer the desired analyses, user friendly JMP is used.

Included in Excel and JMP sections are screenshots which allow students to easily create the desired statistics. Featured are a number of popular Excel shortcuts, which are, themselves, a competitive advantage.

Powerful PivotTables and PivotCharts are introduced early and used throughout the book. Results are illustrated with graphics from Excel.

In each chapter, assignments or cases are included to allow students to practice using statistics for decision making and competitive advantage.

## Focus Is on What Statistics Mean to Decision Makers and How to Communicate Results

From the beginning, results are translated into English. In Chapter 7, results are condensed and summarized in PowerPoints and memos, the standards of communication in businesses. Later chapters include example memos for students to use as templates, making communication of statistics for decision making an easy skill to master.

Instructors, give your students the powerful skills that they will use to create competitive advantages as decision makers. Students, be prepared to discover that statistics are a powerful competitive advantage. Your mastery of the essential skills of creating and communicating statistics for improved decision making will enhance your career and make numbers fun.

## New in the Fifth Edition

A number of new cases have been added, some focusing on multinationals. Some cases from earlier editions have been updated, as well.

Because Excel does not offer every type of analysis, JMP is introduced to handle analysis where Excel cannot be. JMP is user friendly, popular, and widely available in businesses. Nonetheless, Excel is invaluable for building great models and understanding where the statistics come from.

## Acknowledgements

First, Second, Third and Fourth editions of *Business Statistics for Competitive Advantage* were used in the Integrated Core Curriculum at The McIntire School, University of Virginia, and I thank the many bright, motivated and enthusiastic students who provided comments and suggestions.

*Cynthia Fraser  
Charlottesville, VA*