Business Case Analysis with R

Simulation Tutorials to Support Complex Business Decisions

Robert D. Brown III
To Jan, who has provided unyielding support for my various crazy projects over the years, especially when I said, “I’m going to write a book.”

And, to my parents, who first instilled in me a lifelong pursuit of learning.

I love you all.
# Table of Contents

About the Author ..................................................................................................... ix
About the Technical Reviewer ............................................................................... xi
Acknowledgments ................................................................................................. xiii
Introduction .............................................................................................................. xv

## Part 1: Business Case Analysis with R ................................................................. 1

**Chapter 1: A Relief from Spreadsheet Misery** ....................................................... 3

- Why Use R for Business Case Analysis? ............................................................... 3
- What You Will Learn .......................................................................................... 8
- What You Will Need .......................................................................................... 8

**Chapter 2: Setting Up the Analysis** ................................................................. 9

- The Case Study ................................................................................................. 9
  - Deterministic Base Case .................................................................................. 9
  - The Risk Layer ............................................................................................... 10
- Abstract the Case Study with an Influence Diagram ........................................ 11
- Set Up the File Structure .................................................................................. 15
- Style Guide ....................................................................................................... 16
- Write the Deterministic Financial Model .......................................................... 18
  - Data File ....................................................................................................... 18
  - CAPEX Block ............................................................................................... 21
  - Sales and Revenue Block ............................................................................. 27
  - OPEX Block ................................................................................................. 30
  - Pro Forma Block ........................................................................................... 31
  - Net Present Value ......................................................................................... 33
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write a Pro Forma Table</td>
<td>38</td>
</tr>
<tr>
<td>Conduct Deterministic Sensitivity Analysis</td>
<td>40</td>
</tr>
<tr>
<td><strong>Chapter 3: Include Uncertainty in the Financial Analysis</strong></td>
<td>47</td>
</tr>
<tr>
<td>Why and How Do We Represent Uncertainty?</td>
<td>47</td>
</tr>
<tr>
<td>What Is Monte Carlo Simulation?</td>
<td>49</td>
</tr>
<tr>
<td>The Matrix Structure of Business Case Simulation in R</td>
<td>52</td>
</tr>
<tr>
<td>Useful Distributions for Expert Elicited Assumptions</td>
<td>53</td>
</tr>
<tr>
<td>Discrete Distributions: McNamee-Celona and Swanson-Megill</td>
<td>53</td>
</tr>
<tr>
<td>Continuous Distributions</td>
<td>56</td>
</tr>
<tr>
<td>Modify the Influence Diagram to Reflect the Risk Layer</td>
<td>67</td>
</tr>
<tr>
<td>Include the Run Index</td>
<td>69</td>
</tr>
<tr>
<td><strong>Chapter 4: Interpreting and Communicating Insights</strong></td>
<td>79</td>
</tr>
<tr>
<td>Cash Flow and Cumulative Cash Flow with Probability Bands</td>
<td>79</td>
</tr>
<tr>
<td>The Histogram of NPV</td>
<td>84</td>
</tr>
<tr>
<td>The Cumulative Probability Distribution of NPV</td>
<td>86</td>
</tr>
<tr>
<td>The Waterfall Chart of the Pro Forma Present Values</td>
<td>88</td>
</tr>
<tr>
<td>The Tornado Sensitivity Chart</td>
<td>90</td>
</tr>
<tr>
<td>Closing Comments</td>
<td>101</td>
</tr>
<tr>
<td><strong>Part 2: It’s Your Move</strong></td>
<td>103</td>
</tr>
<tr>
<td><strong>Chapter 5: “What Should I Do?”</strong></td>
<td>105</td>
</tr>
<tr>
<td>Three Tools to Clarify Your Thoughts</td>
<td>106</td>
</tr>
<tr>
<td>The Full Scope of Effective Decision Making</td>
<td>108</td>
</tr>
<tr>
<td>Definitions</td>
<td>110</td>
</tr>
<tr>
<td>What You Will Learn</td>
<td>112</td>
</tr>
<tr>
<td>Complementary Resource: Integrated Decision Hierarchy and Strategy Table Template</td>
<td>112</td>
</tr>
<tr>
<td><strong>Chapter 6: Use a Decision Hierarchy to Categorize Decision Types</strong></td>
<td>113</td>
</tr>
<tr>
<td><strong>Chapter 7: Tame Decision Complexity by Creating a Strategy Table</strong></td>
<td>121</td>
</tr>
</tbody>
</table>
## Table of Contents

### Chapter 8: Clearly Communicate the Intentions of Decision Strategies .......... 125

### Chapter 9: What Comes Next ................................................................................ 129

- What You Should Do .......................................................................................... 129
- What You Should Not Do .................................................................................. 130

### Part 3: Subject Matter Expert Elicitation Guide .......................................... 133

### Chapter 10: “What’s Your Number, Pardner?” ...................................................... 135

- What You Will Learn ...................................................................................... 140

### Chapter 11: Conducting SME Elicitations ............................................................. 141

- The Good SME ................................................................................................. 141
- Conduct the Assessment .................................................................................. 143
  - Define the Uncertain Event ......................................................................... 144
  - Identify the Sources of Bias ........................................................................ 144
  - Postulate and Document Causes of Extrema ............................................. 145
  - Measure the Range of Uncertain Events with Probabilities ...................... 148
  - Discrete Binary Uncertainties ...................................................................... 149
  - Continuous Uncertainties ............................................................................ 156
  - Document the SME Interview ..................................................................... 162
  - It’s Just an Opinion, Right? .......................................................................... 162

### Chapter 12: Kinds of Biases ............................................................................. 165

### Part 4: Information Espresso ...................................................................... 169

### Chapter 13: Setting a Budget for Making Decisions Clearly ................................. 171

- What You Will Learn ...................................................................................... 174

### Chapter 14: A More Refined Explanation of VOI .................................................. 175

- The Decision Tree ............................................................................................. 175
- Some Preliminary R Code ............................................................................... 180
- The Influence Diagram ..................................................................................... 183
# Table of Contents

## Chapter 15: Building the Simulation in R
- The Model Algorithms ............................................................... 188
- The Sensitivity Analysis ............................................................. 200
- VOI Algorithms ........................................................................ 206
  - Coarse Focus First ................................................................. 206
  - The Finer Focus .................................................................... 209
- Concluding Comments .............................................................. 218
- Espresso Shot 1 ...................................................................... 219
- Espresso Shot 2 ...................................................................... 219
- Espresso Shot 3 ...................................................................... 219

## Appendix A: Deterministic Model ............................................ 221

## Appendix B: Risk Model .......................................................... 231

## Appendix C: Simulation and Finance Functions ....................... 249

## Appendix D: Decision Hierarchy and Strategy Table Templates 257
- Decision Hierarchy Worksheet ................................................. 257
- Decision Issues ....................................................................... 257
- Strategy Table Worksheet ....................................................... 259
- Strategy Rationales Worksheet ................................................ 260

## Appendix E: VOI Code Samples ................................................. 261
- Preliminary VOI Example ........................................................ 261
- VOI R Scripts ......................................................................... 261
  - Functions ............................................................................. 262
  - Assumptions ........................................................................ 267
  - Business Decision Model .................................................... 268
  - Sensitivity Analysis ............................................................ 271
  - Value of Information 1: Coarse ........................................... 273
  - Value of Information 2: Fine ............................................... 274

## Index .................................................................................... 277
About the Author

Robert D. Brown III is the President of Incite! Decision Technologies LLC, a consultancy supporting senior decision makers facing complex, high-risk opportunities. These opportunities usually include strategic planning, project selection, planning and risk management, and project portfolio analysis and management.

Mr. Brown has devoted his 20-year career to providing solutions to his clients’ complex problems by employing creative thinking and advanced quantitative business, engineering, and systems analysis. His client experience spans diverse industrial and commercial fields including petroleum and chemicals, energy, utilities, logistics and transportation, pharmaceuticals, electronics manufacturing, telecommunications, IT, commercial real estate, federal agencies, and education.

Through Incite!, Mr. Brown delivers analysis, decision support tools and systems, and training in decision making and risk management. His goal is to help people measure the value and the risk associated with the important decisions they face to make informed trade-offs and choices.

Mr. Brown graduated from the Georgia Institute of Technology in 1992 with a bachelor’s degree in mechanical engineering (Co-op program).
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Acknowledgments

This book would never have come to fruition had it not been for the Atlanta R User’s Group led by Derek Norton of Microsoft (formerly Revolution Analytics). They were the first group to hear my pitch for the ideas I had about how R might be used in a different way than typically employed by data scientists. Derek especially provided some key insights into the syntax of R and encouraged me to expand my ideas into what eventually became the first distributed precursor to this book.

Next, a big thank you goes to Dwight Barry. Dwight was one of the original readers of the first version of this book, giving it a glowing review that continues to warm my heart today. Being a fellow code monkey (author of his own Business Intelligence with R [Leanpub, 2016]), Dwight graciously offered to act as the technical reviewer on this project, providing an expert eye for cleaning up my code and tightening some of the language describing complex ideas. Of course, any ambiguity or clumsiness that remains is entirely due to my own failings as an author. Although he required little incentive from me to provide the technical review of this book, Dwight still did so as a distraction from his very important work with the data science group at the Seattle Children’s Hospital and from his family over the 2017 winter holidays. Dwight is a code monkey with a heart.

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Introduction

Welcome to Business Case Analysis with R: Simulation Tutorials to Support Complex Business Decisions. This book first appeared as a series of four short, self-published tutorials conceived to provide specific guidance in tricky areas associated with the delivery process of project business case and risk analysis. Each tutorial was intended to be read in one to three hours, spanning no more than 100 pages so that the reader can understand big ideas quickly on a first pass. With this publication, we bring those tutorials together in a more integrated fashion as a single volume of four parts.

Although each of the four parts can still be read independently, I recommend taking them in the order of their presentation in the text. Part 1 represents the namesake of the current volume, “Business Case Analysis with R: Simulate Complex Business Decisions with Greater Transparency.” This is a tutorial for learning how to use the statistical programming language R to develop a business case simulation and analysis with greater transparency, efficiency, and accuracy than is possible with spreadsheets.

The tutorial follows the case in which a chemical manufacturing company considers constructing a chemical reactor and production facility to bring a new compound to market. There are numerous uncertainties and risks involved, including the possibility that a competitor will bring a similar product online. The company must determine the value of making the decision to move forward and where they might prioritize their attention to make a more informed and robust decision. Although the example used is a chemical company, the analysis structure it presents can be applied to just about any business decision, from IT projects to new product development to commercial real estate. In this section, you will learn how to do the following:

1. Set up a business case abstraction.
2. Model the inherent uncertainties in the problem with Monte Carlo simulation.
3. Develop sensitivity analysis that tells you which uncertain effects matter most.
4. Communicate the results graphically.
5. Draw appropriate insights from the results.
INTRODUCTION

Business case analysis of a new opportunity or problem solution is never complete, however, unless we answer this question: “Compared to what?” Answering this question is the business of opportunity cost analysis. Unfortunately, when people even remember to do opportunity cost analysis, they set it up incorrectly in either one of two ways.

First, they might consider a “mostly best” solution to their problem or opportunity, then they try to account for the variation it might experience by applying different levels of scenarios (i.e., low, most likely, and high) to key uncertainties. There are two problems with this approach:

- It doesn’t account for the probability that any of those scenarios will occur.
- It treats the opportunity costs as arising from the existential variation on a given choice as opposed to considering the net conditional value between purposefully distinct choices.

Opportunity cost is about the trade-off in value for what we choose to do as opposed to what can happen to us in any given choice.

Second, they might try to consider the pros and cons of individual decision alternatives, but they soon face the realization that business decisions are really composed of multiple coordinated decision alternatives in which the possible combinations of alternatives approach hundreds if not thousands, nor can each alternative be treated independently. The confusion that arises from this situation usually propels the analysis back to the first approach: Pick a “mostly best” solution and try to account for possible scenario variations.

The purpose, then, of Part 2, “It’s Your Move: Create Valuable Strategic Decisions When You Don’t Know What to Do,” is to show you how to simplify this thought process by using three thinking devices called the decision hierarchy, the strategy table, and a qualitative description table to frame creative decision strategies that effectively reduce the decision complexity of business case analysis. It gives you the ability to create the right combinations of decision alternatives for opportunity cost analysis without getting mired in testing all of the possible combinations or simplistically guessing at the best pathway to take at too high of a level of consideration. This sets the stage for conducting opportunity cost analysis in the right way by answering this question: What is the value of doing A versus B, C, or D?
Of course, we must still account for the existential variation that we can experience in any strategic pathway we choose. We need to give consideration to the effects of outcomes we cannot control and their relative likelihood of occurring. This feels like it should be satisfied through the statistical analysis of data. Unfortunately, here again, business analysts often face a significant problem: Where does one get the data, especially if the decision problems at hand merit new-to-the-world solutions and the solutions would be counterfactuals to each other? The answer is that we construct the data from subjective expert guidance via an objective process. Part 3, “Subject Matter Expert Elicitation Guide: Assess Uncertainties When You Don’t Have (Much) Data or a Clairvoyant,” provides a facilitation framework for overcoming many of the spoilers to clear thinking while providing a means to account rationally for uncertainty in business case analysis. It will help you do the following:

1. Recognize appropriate subject matter experts (SMEs) to use in assessing information about uncertain events.
2. Provide you with a kind of script for helping SMEs acknowledge and assess their own bias.
3. Provide you with a routine to elicit the appropriate information from SMEs required to support high-quality business case analysis.

This section provides the basis for the characterization of uncertainty employed in Part 1 and finally in Part 4.

Opportunity cost analysis done correctly often leads to the realization that several material uncertainties can pose a significant possibility that we will experience regret for taking the best indicated decision strategy over the next best one given the information we have at hand (often constructed from expert guidance). We need a tool to determine just how much we should budget to improve the quality of the information we possess about the uncertainties and prioritize our attention on them. Otherwise, we run the risk of either incurring too much exposure or spending too much to achieve the confidence that we have chosen well. Part 4, “Information Espresso: Use Value of Information to Make Clear Decisions Efficiently,” provides just such needed guidance by returning us to the roots of the title of this volume, using the R programming language.
to achieve greater transparency into the value of the decisions we want to make. In this section, you will learn the following:

1. The meaning of value of information.
2. How to identify critical uncertainties using tornado charts.
3. How to calculate the value of information using R.

You can download the source code from this book’s product page at www.apress.com/9781484234945 by clicking the source code button there. If you want to read this source code in a noncomputing medium (i.e., ebook or print book), Appendices A through E also contain the uninterrupted R source code and SME elicitation instructions.

My hope is that by using these tools you can accelerate and improve the value you bring to your own career as an analyst, and by doing so, create value for everyone who benefits from your improved skill and acumen. If you find that you enjoy and benefit from this book, please help spread the word by tweeting #BizSimWithR and include me on the tweet at @InciteDecisions.