Introduction to
Spreadsheet Methods in
Business and Economics

Frank S.T. Hsiao
University of Colorado at Boulder
Boulder, Colorado

Michael Luzius
American Intercontinental University
Chicago, Illinois

(c) Frank S.T. Hsiao and Michael Luzius
Introduction to Spreadsheet Methods in Business and Economics

(Tentative)


Preface

Most 21st century students are familiar with microcomputers. They are adept in visually oriented learning and playing, whether through video games, music videos, DVDs, iPod, or the internet. This book appeals to the computer skills of modern day undergraduate and graduate students through innovative uses of spreadsheets, including built-in spreadsheets, equations, and formulas.

This computer skill-intensive book covers major topics in both economic and business analysis. Students will learn how to build complex spreadsheet layouts and perform high-level calculation and analysis using the popular spreadsheet program Microsoft Excel. The exposition of the basic concepts, models, and interpretations are presented intuitively and graphically without compromising the rigor of analysis. We study Economics, Business, Mathematics, and Statistics systematically and with hands-on practice while learning Excel.

To encourage students’ active learning and critical thinking, they will be given hands-on experiences by creating tables and graphs presented in the text and practice questions. They will be able to change parameters within spreadsheets and see the effects of change instantly. At the same time, by acquainting themselves with Microsoft Excel, students will directly acquire practical and advanced job skills.

The book is intended for third or fourth year (upper-level undergraduate) economics or business majors in colleges and universities, and first-year graduate students in MA programs in economics and business. The book is a stand-alone full textbook for one semester, but, depending on the pace of instruction (if Excel commands have to be covered extensively), it can be extended to two semesters. It can also serve as a supplement to textbooks on principles of economics, intermediate economics, and introductory statistics.

The Features, Tools, Structure, and Advantages of this Book

There are many unique and innovative features in this book, which have been developed by the author over the past twenty five years through teaching a course using the manuscript of this textbook and from his research on computer assisted learning (CAL).

Our new systematic approach of unifying economics, business, mathematics, statistics, and spreadsheet programs is probably the first of its kind in the area of quantitative methods. The following is a summary and explanation of the unique features, tools, structure, and advantages of our approach.
A. The features of this book

(1) The book contains major topics in economics, such as the derivation of the demand and supply curves and utility and production optimization models in microeconomics, national income models, economic policy analysis, and dynamic models in macroeconomics. These topics are also shared by managerial economics. On the other hand, the book also covers some of the major topics in business economics, including future and present value problems with or without annuity, probability, statistics, regression analysis, flow charts, and PowerPoint slide presentations. Due to recent emphasis on integrated and interdisciplinary studies, more and more economics majors are also interested in these business topics, and more business majors are also interested in microeconomics and macroeconomics.

(2) For both students and instructors, instead of spending time in programming, using software like C+, we feel that it is much easier to spend time on spreadsheet construction and learn economic modeling first-hand, using spreadsheet commands directly. If the proprietary software programs are used in teaching, the students download the program as add-ins, they will miss hands-on practice opportunities. This is a black box we would like to avoid. While it is true that proprietary software programs may be more powerful and may introduce more advanced or sophisticated methods or topics, we submit that such advanced or sophisticated methods or topics may not be appropriate at the undergraduate level.

(3) We emphasize the economic interpretation and policy implications of the models and computer output results, and the applicability of the models to real world issues in economics and business. For example, in teaching linear policy models, we systematically present the effects of fiscal, monetary, and consumption policies on equilibrium income and consumption, by simply changing the parameters in the model. We present it as the prototype of the more sophisticated federal government’s economic policy, and all analyses are carried out easily by finding an inverse matrix. If a model does not make economic sense, we ask students to change the model (like parameter values) so that the model is plausible.

(4) The book combines major concepts and tools in economics and related topics in statistics, mathematics, and spreadsheet programs. As an upper level undergraduate textbook, it can also serve as a review of the materials for students who have previously studied introductory economics and business courses, and give students a different, unified perspective on previous courses. For example, we emphasize the similarity of demand and supply relations in microeconomic market models and in the aggregate demand/supply macroeconomic income determination models, the relationships between static and dynamic microeconomic and macroeconomic models, the relationship between numerical demand and supply equations, the method of estimating these equations, and other topics.

(5) The book appeals to the intuitive and visual understanding of complex economics, business, statistics, and mathematics topics, such as unconstrained and constrained optimization problems, through the use of spreadsheets. In fact, our method of using 3D and 2D contour maps makes it easy for students to visualize optimization problems on spreadsheets, before going through the first and second order conditions or LaGrange function method for optimization using calculus.

(6) “Computer assisted teaching” also enables the students to take the “computer assisted testing”. Unlike traditional written tests, this book allows students to use computers to perform complicated calculations, such as accurate comparative static analysis (Chapter 4), estimating multiple regression coefficients, hypothesis testing (Chapter 7),
finding the solution to a large system of simultaneous equations (Chapter 10), and giving economic interpretations to the results during the examinations. This eliminates the need for take-home examinations.

(7) Since the calculations are performed by computer, the instructor has more time to concentrate on teaching the procedures of computing, economic and business concepts, and interpretation or explanation of results. Our basic philosophy is reflected in the questions presented in the homework assignments for each chapter. They are mostly collections of past mid-term or final examinations that the author has used in this course. Note that few homework questions are purely mathematical or statistical; yet, due to the complete integration with microcomputer techniques, the level of these homework questions is quite advanced and challenging, and at least comparable to, if not exceeding, the difficulty of course materials in intermediate microeconomics or macroeconomics.

(8) More importantly, the tables and charts in the book are not only used to illustrate explanation of definitions, theories, and applications of topics, as in most textbooks, but are also presented to that students can reproduce or reconstruct the tables and charts using Microsoft Excel, to gain better understanding of the topics and deeper insight into the concepts and methods.

(9) The textbook is self-contained. Through innovative uses of spreadsheets and builtin spreadsheet equations and formulas, we are able to present all these topics in one book. We do not use homemade add-in spreadsheet macro programs, proprietary software programs, or additional data sets by attaching a CD to the book. We emphasize hands-on practice; all models are built with the students, step-by-step, on site in the classroom. All data sets, except in Chapter 14, where students practice how to download on-line data, are also generated by the students in the classroom through the use of a random number generator. In general, unlike the practice of workbooks or study guides of other textbooks, the basic concepts are explained concisely and rigorously in each chapter. We provide key terms in economics and business and key terms in Excel commands at the end of each chapter for review, and the basic topics are illustrated by a flowchart at the end of chapters.

B. On analytical tools

(1) We use only algebraic operations. Calculus is not required. The exposition of the basic concepts, models, and interpretations are presented intuitively and graphically without compromising the rigor of analysis. We study Economics, Business, Mathematics, and Statistics systematically and with hands-on practice while learning Excel. To maintain rigor and clarity of exposition, we introduce the concept of difference to explain the change of variables, which is then used extensively in the last chapter on difference equations.

(2) We place emphasis on teaching the class to understand intermediate and some advanced concepts in economics and business without being inhibited by the technicalities of mathematics and computer programming. For example, we introduce and illustrate the income and substitution effects of price change in demand, total factor productivity, and the golden rule of capital accumulation without getting into complicated mathematics or computer programming.

(3) In this book, learning spreadsheet commands advances with the progress of each chapter, along with improvement in statistical and mathematical modeling skills. From statics to comparative statics, from dynamics to comparative dynamics, the sequence of commands builds up naturally, and the spreadsheet commands are a joy for students to learn and instructors to teach. For example, when we study comparative statics in Chapter 4, we introduce the naming method and picture copy command, so that students
will know immediately the uses and advantages of these commands. Thus, the spreadsheet commands are introduced in the context of economic and business applications. These commands are also used in other chapters, and students have opportunities to reinforce their previous learning.

(4) In addition to simulation methods and constructing data sets in the classroom setting, we also introduce how and where to download government and international data sources, and we practice the research methods of extracting useful information through Excel’s data analysis tools: sorting, subtotalling, auto-filtering, and pivotal tables and graphs.

**Advantages of using spreadsheets**

(1) By using the random number generating device in the Microsoft Excel program and what we call the “naming method”, students can generate their own simulated and yet realistic data sets, and change the parameters to find out how they change the economic solutions and the graphic images by their hands-on practice. The ease of generating a data set, as compared to entering external data by typing or downloading the data from a website, encourages students to engage in active learning that they initiate themselves. In addition, the random numbers are “live” and students really enjoy “dancing” numbers and curves by simply pressing the recalc (F9) key.

(2) We have devised a powerful and versatile “naming method” to prepare sensitivity tables to illustrate the functional relations in three-dimensional graphs instantly. For example, this method can illustrate easily any two-independent-variable function \( z = f(x, y) \). Our method avoids the problems of relative and absolute references in copying a formulas or the need for either prepacked commercial or homemade add-in programs. We have also solved the classroom problem of quickly implementing a complicated equation into tables without importing add-ins.

(3) We apply the “naming method” and the “picture copy command (PCC)” to illustrate and learn comparative statics and comparative dynamics in economics. Many current computer-assisted instruction (CAI) programs do not use the naming method or the picture copy command, making teaching and learning comparative statics and comparative dynamics quite tedious and time consuming, as the students have to change formulas and equations each time, instead of just changing the parameters.

(4) The naming method, the picture copy command, and the range copy command (RCC) used extensively in this book enable students to reproduce different comparative statics graphs and arrange them in one sheet in the same workbook beautifully. All the above RCC and PCC can be performed within 15 minutes or less, even during course examinations. In this sense, we submit that our methods “revolutionize” the presentation of economics in Excel, and can be applied in many other fields in business and sciences.

(5) By combining the built-in Excel Solver for the optimization program and the graphic methods, students can find and illustrate solutions to optimization problems as accurately as possible. By changing the parameters, they can experiment with the impacts on solutions as many times as they like. They even can invent their own optimization problems.

(6) We emphasize the one-to-one correspondence between data table and chart.
Students are not only able to draw the charts, they are required to find the correspondence between lines and curves in charts and numbers in the table. For example, they must find the equilibrium price and quantity of the demand and supply curves in the chart as well as in the table. They also will be asked to change the parameters of the model and trace out how the correspondence has been changed.

(7) Since the charts can show different widths for horizontal and vertical grid lines, using them is the same as using plotting paper in the pre-computer era several decades ago. Instead of the students drawing charts manually, the computer can draw the charts accurately and neatly. Students can change the scales of drawings, zoom in and zoom out, and get a feeling for the charts.

(8) Since charts and tables can be colored or boxed, we encourage students to present the tables and charts in as colorful and pleasant forms as they can. For example, students enter the formula of the CES function themselves and set up the three-dimensional surface. Then we encourage them to color the table and charts in presenting their results. They learn and have a lot of fun painting. This experience will not be possible in traditional economics, business, and quantitative textbooks.

(9) We have devised a method of constructing a sample with large data set instantly, such as randomly generated uniform, normal, or student-t distributions, or large sets of records with many fields (like region, month, year, gender, political affiliation, etc.), using random numbers and the IF function, for practice in the classroom. This cannot be done in traditional textbooks.

Preparing computer skill for job markets

(1) This is a skill intensive book in which students learn the skills of using spreadsheets for research and presentations on the job after they graduate. For example, we include the methods of constructing flow charts and presentations by Microsoft PowerPoint. We also include some aspects of business mathematics, like future and present value problems, with and without annuity calculations, which are then tied to the exponential functions and logarithmic functions used in the theory of economic growth. We also build loan amortization tables and methods of constructing index numbers. Students as well as the general readers may use the techniques to work on their personal financial planning.

(2) One of the difficulties in using Excel is that it requires students to learn “idiosyncratic” spreadsheet commands. In this book, the spreadsheet commands are introduced systematically from simple to complex commands in a natural way as we cover more chapters. In recent years, most students already have used or are even familiar with some Excel commands before taking the class, and thus learning Excel commands is not a big problem. They can quickly get into economics and business applications in this book. Furthermore, the spreadsheet skills and applications learned in this book are useful when the students graduate and take jobs in banks, business, or government,
or international organizations. In fact, the spreadsheet skills they learn from this book may be among the most useful tools that they learn in their college years.

About the Author

Frank S.T. Hsiao received his B.A. and M.A. in Economics from the National Taiwan University, Taipei, Taiwan, and M.A. and Ph.D. in Economics from the University of Rochester, Rochester, NY. From 1966 to 2007, he was a full-time professor in the Department of Economics at the University of Colorado at Boulder. He taught undergraduate and graduate courses on Mathematical Economics (Statics and Dynamics), Economic Statistics, and Microcomputer Applications in Economics, using many of the techniques and models described in this book.

Professor Hsiao’s expertise has been recognized internationally through many lectures at universities and institutes in Japan, the Netherlands, Mexico, Taiwan, Korea, Malaysia, Thailand, Hong Kong, and China. He has also been a visiting scholar at the Fairbank Center for East Asian Research of Harvard University; the Hoover Institute of Stanford University; Hitotsubashi University, Nagoya University, the International Centre for the Study of East Asian Development, etc., in Japan.


Currently, Dr. Hsiao is Professor Emeritus of Economics in the Department of Economics, University of Colorado at Boulder, and is an Associate Editor for the Journal of Asian Economics.
Contents
(Tentative)

Chapter 1 The Excel Worksheets
Some conventions used in this book
1.1 General Worksheet Properties
1.2 Pointer Movements
1.3 Generating random numbers
1.4 Upper left corner and the formula bar
   1.4.1 The first part of the upper left corner
   1.4.2 The second part of the upper left corner
1.5 Upper right corner
1.6 Lower right corner
1.7 Lower left corner
1.8 Printer Basics
1.9 Summary

Chapter 2 The Structure of the Home Ribbon
   Chapter Outline
   Objectives of this chapter
   2.1 A summary of ribbon and group names
2.2 The left-hand side of the Home ribbon – basic formatting
   2.2.1 Name of the Basic Logos
   2.2.2 Moving and copyng a range
   2.3 The right-hand side of the Home ribbon — advanced formatting
2.4 The mini toolbar
   2.4.1 The drawing toolbar
   2.4.2. The Drawing arrow
   2.4.3 The text box
2.5 Use of Text Box and Shapes
2.6 Summary
Extended Examples Chapter 2

Chapter 3 Excel Tables and Simple Charting—Financial Tables
   Objectives of this chapter
3.1 Mathematical Operations and formulas
3.2 Construction of a Financial Table I
   3.2.1 Construction of a financial table
   3.2.2 Copying, Printing and saving the Table
3.3 Construction of a Financial Table II
   3.3.1 Theoretical background
   3.3.2 Steps of Constructing a Financial Table II
3.4 Simple Charting
Extended Examples Chapter 3

Chapter 4 References, Naming, and Advanced Graphics
   Chapter Outline
4.1 Relative and absolute references
4.1.1 What are References?
4.1.2 The F4 (ABS) key

4.2 Name That Range!
4.2.1 Single range name (the name box method)
   4.2.2 Multiple-naming method
   4.2.3 Using the naming method to complete the table
4.2.4 Rules and New Name dialog box

4.3 Advanced topics in Naming
   4.3.1 Some rules and New Name dialog box
   4.3.2 On the scope of name range
   4.3.3 Changing or deleting a range name
   4.3.4 Changing to range names retrospectively

4.4 Advanced Graphic Methods
   4.4.1 Problems for improvement
   4.4.2 Editing the Chart Area borders
   4.4.3 Other three methods of editing chart elements
   4.4.4 Editing the chart titles and axes
   4.4.5 Editing the curves and lines
   4.4.6 The secondary vertical axis and data labels

4.5 Charts and Tables - advanced topics
   4.5.1 Reconnecting table with the chart
   4.5.2 Separating the chart without pain
   4.5.3 Comparison of the charts
   4.5.4 Mathematical Conditions of Profit Maximization

Chapter 5 Summarizing a Dataset
—Descriptive Statistics and Financial Analysis (not printed)

Chapter Outline
Objectives of this chapter
5.1 Generating a Dataset
   5.1.1 The discrete frequency distribution
   5.1.2 Continuous frequency distribution

5.2 Frequency Charts
   5.2.1 The column chart
   5.2.2 Histogram
   5.2.3 Polygon
   5.2.4 Combination of Histogram and Polygon

5.3 Frequency Chart for the Relative Frequency Distribution

5.4 A Composite Charts and Pie Charts

5.5 Charts for Continuous sample frequency distributions

5.6 Cumulative Charts (Ogives)

5.7 Basic Descriptive Statistics
   5.7.1 The Basic Excel Table
   5.7.2 Measures of the central tendency of a distribution
   5.7.3 Measures of the spread of a distribution
   5.7.4 Measures of Shape
5.7.5 Excel Data Analysis
5.8 Some Other Statistical Measurements
   5.8.1 Growth rates
   5.8.2 Elasticity
   5.8.3 Financial tables
5.9 Financial ratio analysis
   5.9.1 Ratios related to the Balance Sheet
   5.9.2 Ratios related to the income statement
   5.9.3 Ratios related to both balance sheet and income statement

-----------------------

Chapter 6 Relations—Correlation and Regression (not printed)
6.1 Covariance
   6.1.1 Definitions
   6.1.2 Manual calculation
   6.1.3 Excel formula for covariance
6.2 Correlation coefficients
   6.2.1 Definitions
   6.2.2 Manual calculation
   6.2.3 Excel formula for correlation coefficient
6.3 Portfolio Return and Portfolio Risk
   6.3.1 Definitions
   6.3.2 Sample estimation
   6.3.3 Excel table implementation
   6.3.4 Excel chart implementation
6.4 The Scatter Diagram and the Trend Line
   6.4.1 Drawing a scatter diagram
   6.4.2 Adding a trend line
   6.4.3 Returns of Assets
   6.4.4 Portfolio returns, portfolio risks, efficient frontier
6.5 The Regression Line
   6.5.1 Simple regression
   6.5.2 Capital Market Line and Security Market Line
6.6 Theory of the Least Squares Method
   6.6.1 The error terms
   6.6.2 The standard error of estimate
6.7 The Coefficient of Determination
   6.7.1 Decomposition of total deviation
   6.7.2 Decomposition of total variation
   6.7.3 Coefficient of determination
6.8 The Add-In Regression Package

Extended Examples

Chapter 7 Multiple Regression (to be completed)

Chapter 8 On LOOKUP, MATCH, and INDEX Functions (not printed)
Chapter Outline
Objectives of this chapter
8.1 The Lookup function – the Telephone Book
8.1.1 Creating the Data Table
8.1.2 The Excel VLOOKUP Function
8.1.3 Finding the value of VLOOKUP Function
8.1.4 Business Applications
8.2 The Case of Multiple Criteria
8.2.1 Assignment of letter grades
8.2.2 Boundaries of an interval
8.3 More Applications of Multiple Criteria-Calculating GPA
8.3.1 Creating the Data Table
8.3.2 Finding the value of VLOOKUP Function
8.4 Excel Insert Function Dialog Box
8.5 Functions Related with VLOOKUP— INDEX and MATCH
8.5.1 MATCH(…)
8.5.2 INDEX(…)
8.6 HLOOKUP and Application to a Financial Table
8.6.1 Construction of The data table
8.6.2 The Excel HLOOKUP function
8.6.3 Finding the value of HLOOKUP Function
8.6.4 HLOOKUP, MATCH, and INDEX functions

References

Chapter 14 PivotTables and PivotCharts (not printed)
Chapter Outline
Objectives of this chapter
14.1 The Uses of PivotTables
14.2 Construction of the Dataset and PivotTable
14.2.1 Constructing a Dataset
14.2.2 Constructing a PivotTable
14.3 A one-axis PivotTable of Columns
14.4 A one-axis PivotTable of Rows
14.5 A Two-axis PivotTable
14.6 A Three-axis PivotTable
14.7 Type of calculation in the Values
14.7.1 Summarize Value Field by Counting
14.7.2 Summarize Value Field by Averaging
14.8 Multiple-layers of axis
14.9 Grouping of Data – Frequency Distributions
14.10 PivotCharts
14.10.1 Creating PivotChart from the existing PivotTable
14.10.2 Creating PivotChart from the original data table
Extended Examples of Using Excel Data Analysis