Chapter 1

Introduction to Quantitative Analysis

Quantitative Analysis for Management, *Tenth Edition*,
by Render, Stair, and Hanna

Learning Objectives

After completing this chapter, students will be able to:

1. **Describe the quantitative analysis approach**
2. **Understand the application of quantitative analysis in a real situation**
3. **Describe the use of modeling in quantitative analysis**
4. **Use computers and spreadsheet models to perform quantitative analysis**
5. **Discuss possible problems in using quantitative analysis**
6. **Perform a break-even analysis**

Chapter Outline

Introduction

- **Mathematical tools have been used for thousands of years**
- **Quantitative analysis can be applied to a wide variety of problems**
- **It's not enough to just know the mathematics of a technique**
- **One must understand the specific applicability of the technique, its limitations, and its assumptions**

Examples of Quantitative Analyses

- **Taco Bell saved over $150 million using forecasting and scheduling quantitative analysis models**
- **NBC television increased revenues by over $200 million by using quantitative analysis to develop better sales plans**
- **Continental Airlines saved over $40 million using quantitative analysis models to quickly recover from weather delays and other disruptions**

What is Quantitative Analysis?

Quantitative analysis **is a scientific approach to managerial decision making whereby raw data are processed and manipulated resulting in meaningful information**

What is Quantitative Analysis?

Quantitative factors **might be different investment alternatives, interest rates, inventory levels, demand, or labor cost**

Qualitative factors **such as the weather, state and federal legislation, and technology breakthroughs should also be considered**

- **Information may be difficult to quantify but can affect the decision-making process**

The Quantitative Analysis Approach

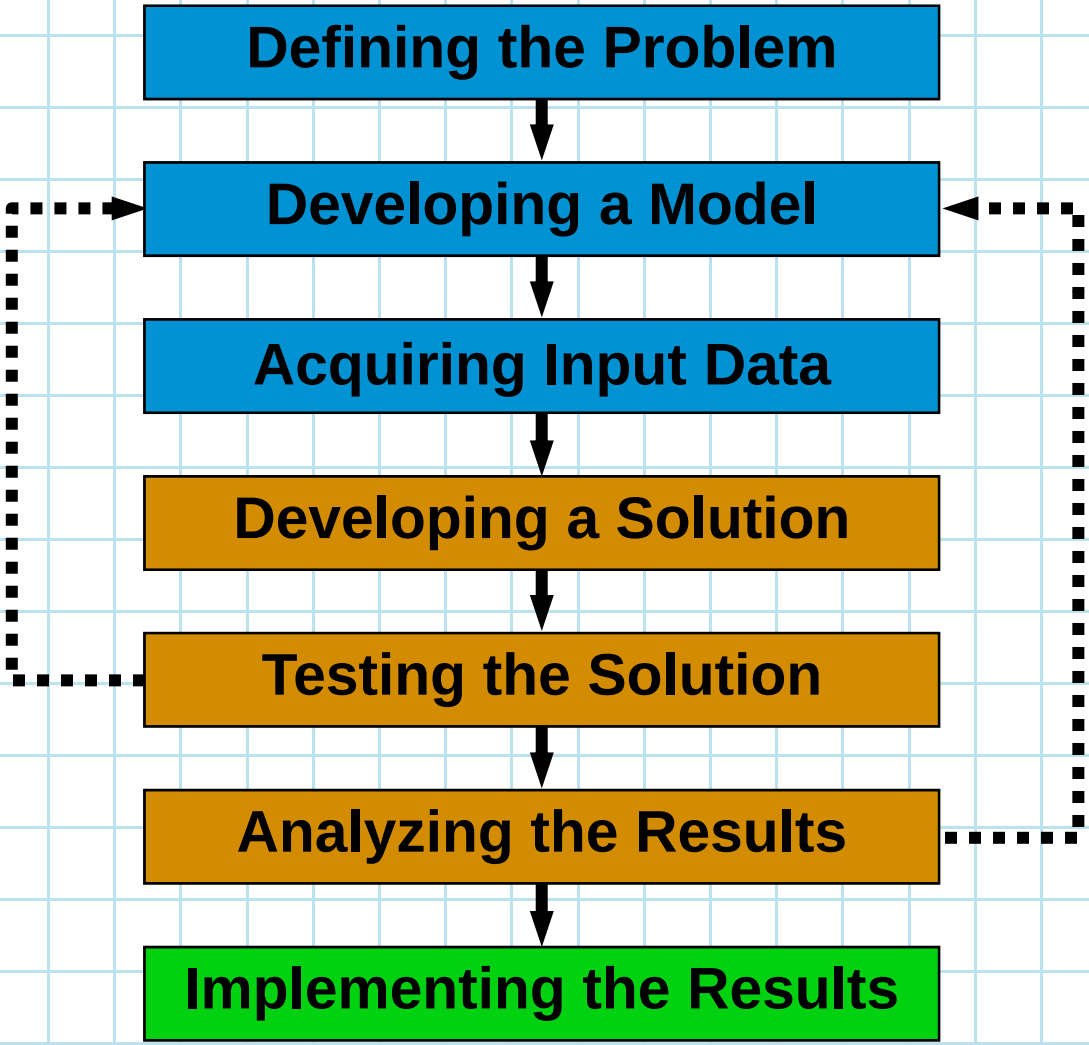


Figure 1.1

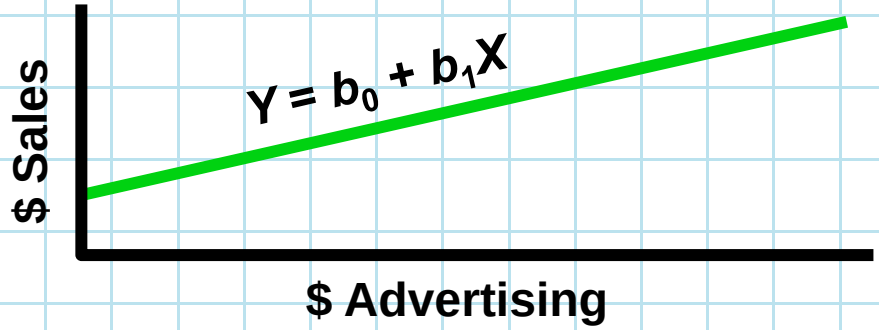
Defining the Problem

Need to develop a clear and concise statement that gives direction and meaning to the following steps

- **This may be the most important and difficult step**
- **It is essential to go beyond symptoms and identify true causes**
- **May be necessary to concentrate on only a few of the problems – selecting the right problems is very important**
- **Specific and measurable objectives may have to be developed**

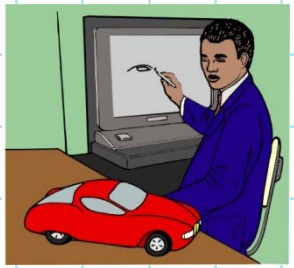
Developing a Model

Quantitative analysis models are realistic, solvable, and understandable mathematical representations of a situation

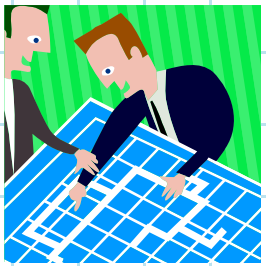


There are different types of models

Scale models



Schematic models

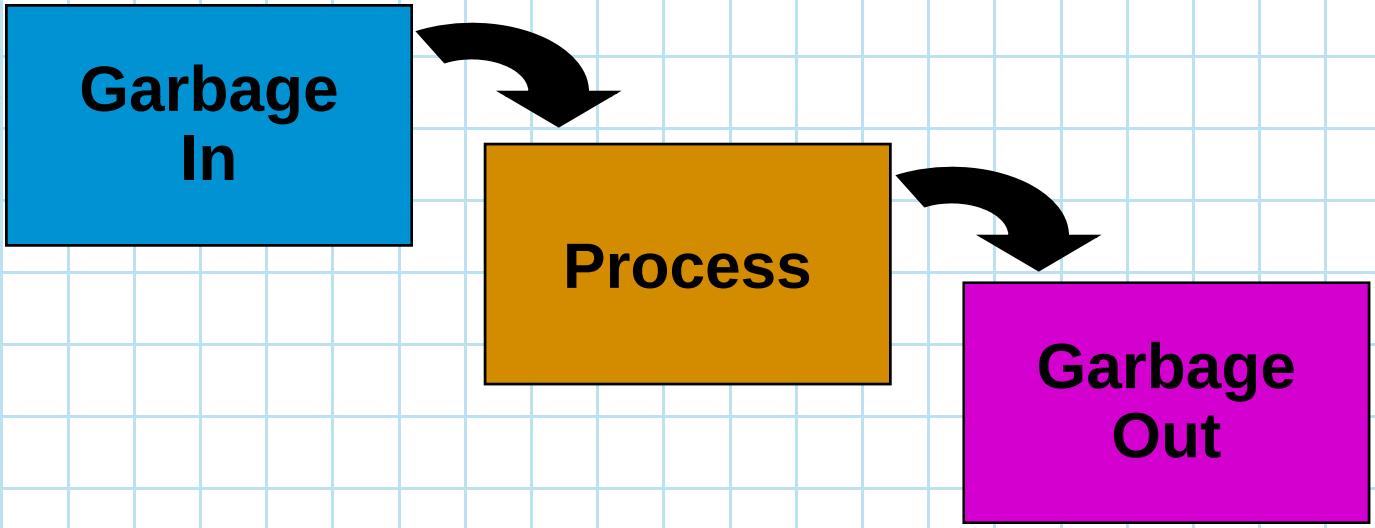


Developing a Model

- **Models generally contain variables (controllable and uncontrollable) and parameters**
- **Controllable variables are generally the decision variables and are generally unknown**
- **Parameters are known quantities that are a part of the problem**

Acquiring Input Data

Input data must be accurate – GIGO rule



Data may come from a variety of sources such as company reports, company documents, interviews, on-site direct measurement, or statistical sampling

Developing a Solution

- **The best (optimal) solution to a problem is found by manipulating the model variables until a solution is found that is practical and can be implemented**
- **Common techniques are**
  - ***Solving* equations**
  - ***Trial and error* – trying various approaches and picking the best result**
  - ***Complete enumeration* – trying all possible values**
  - **Using an *algorithm* – a series of repeating steps to reach a solution**

Testing the Solution

Both input data and the model should be tested for accuracy before analysis and implementation

- **New data can be collected to test the model**
- **Results should be logical, consistent, and represent the real situation**

Analyzing the Results

Determine the implications of the solution

- **Implementing results often requires change in an organization**
- **The impact of actions or changes needs to be studied and understood before implementation**

Sensitivity analysis **determines how much the results of the analysis will change if the model or input data changes**

- **Sensitive models should be very thoroughly tested**

Implementing the Results

Implementation incorporates the solution into the company

- **Implementation can be very difficult**
- **People can resist changes**
- **Many quantitative analysis efforts have failed because a good, workable solution was not properly implemented**

Changes occur over time, so even successful implementations must be monitored to determine if modifications are necessary

Modeling in the Real World

Quantitative analysis models are used extensively by real organizations to solve real problems

- **In the real world, quantitative analysis models can be complex, expensive, and difficult to sell**
- **Following the steps in the process is an important component of success**

How To Develop a Quantitative Analysis Model

- **An important part of the quantitative analysis approach**
- **Let's look at a simple mathematical model of profit**

Profit = Revenue – Expenses

How To Develop a Quantitative Analysis Model

Expenses can be represented as the sum of fixed and variable costs and variable costs are the product of unit costs times the number of units

Profit = Revenue – (Fixed cost + Variable cost)

Profit = (Selling price per unit)(number of units sold) – [Fixed cost + (Variable costs per unit)(Number of units sold)]

Profit = $sX - [f + vX]$

Profit = $sX - f - vX$

where

s = selling price per unit

f = fixed cost

v = variable cost per unit

X = number of units sold

How To Develop a Quantitative Analysis Model

Expenses can be r
variable costs and
unit costs times th

Profit = Revenue

Profit = (Selling
sold) – [
unit)(Nu

Profit = $sX - [f + vX]$

Profit = $sX - f - vX$

where

s = selling price per unit
f = fixed cost
v = variable cost per unit
X = number of units sold

The *parameters* of this model are f, v, and s as these are the inputs inherent in the model

The *decision variable* of interest is X

Pritchett's Precious Time Pieces

The company buys, sells, and repairs old clocks. Rebuilt springs sell for $10 per unit. Fixed cost of equipment to build springs is $1,000. Variable cost for spring material is $5 per unit.

$s = 10$ $f = 1{,}000$ $v = 5$

Number of spring sets sold = X

$$\text{Profits} = sX - f - vX$$

If sales = 0, profits = –$1,000

If sales = 1,000, profits = [(10)(1,000) – 1,000 – (5)(1,000)]

= $4,000

Pritchett's Precious Time Pieces

Companies are often interested in their *break-even point* (BEP). The BEP is the number of units sold that will result in $0 profit.

$$0 = sX - f - vX, \quad \text{or} \quad 0 = (s - v)X - f$$

Solving for X, we have

$$f = (s - v)X$$

$$X = \frac{f}{s - v}$$

$$\text{BEP} = \frac{\textit{Fixed cost}}{\textit{(Selling price per unit) – (Variable cost per unit)}}$$

Pritchett's Precious Time Pieces

C
p
th

BEP for Pritchett's Precious Time Pieces

BEP = $1,000/($10 – $5) = 200 units

Sales of less than 200 units of rebuilt springs will result in a loss

Sales of over 200 units of rebuilt springs will result in a profit

$$\text{BEP} = \frac{\textit{Fixed cost}}{\textit{(Selling price per unit) – (Variable cost per unit)}}$$

Advantages of Mathematical Modeling

1. Models can accurately represent reality
2. Models can help a decision maker formulate problems
3. Models can give us insight and information
4. Models can save time and money in decision making and problem solving
5. A model may be the only way to solve large or complex problems in a timely fashion
6. A model can be used to communicate problems and solutions to others

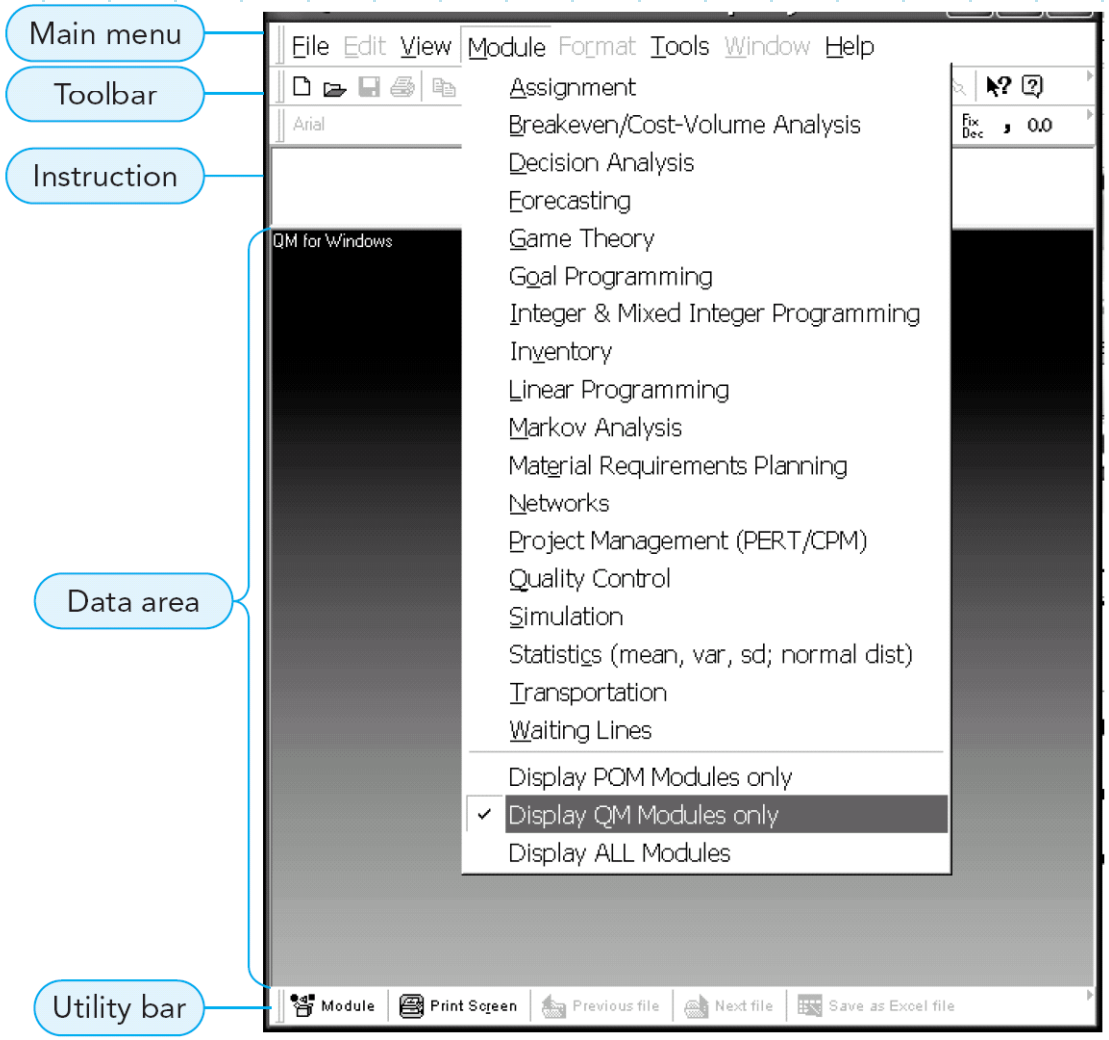
Models Categorized by Risk

- **Mathematical models that do not involve risk are called *deterministic* models**
  - **We know all the values used in the model with complete certainty**
- **Mathematical models that involve risk, chance, or uncertainty are called *probabilistic* models**
  - **Values used in the model are estimates based on probabilities**

Computers and Spreadsheet Models

QM for Windows

- An easy to use decision support system for use in POM and QM courses
- This is the main menu of quantitative models

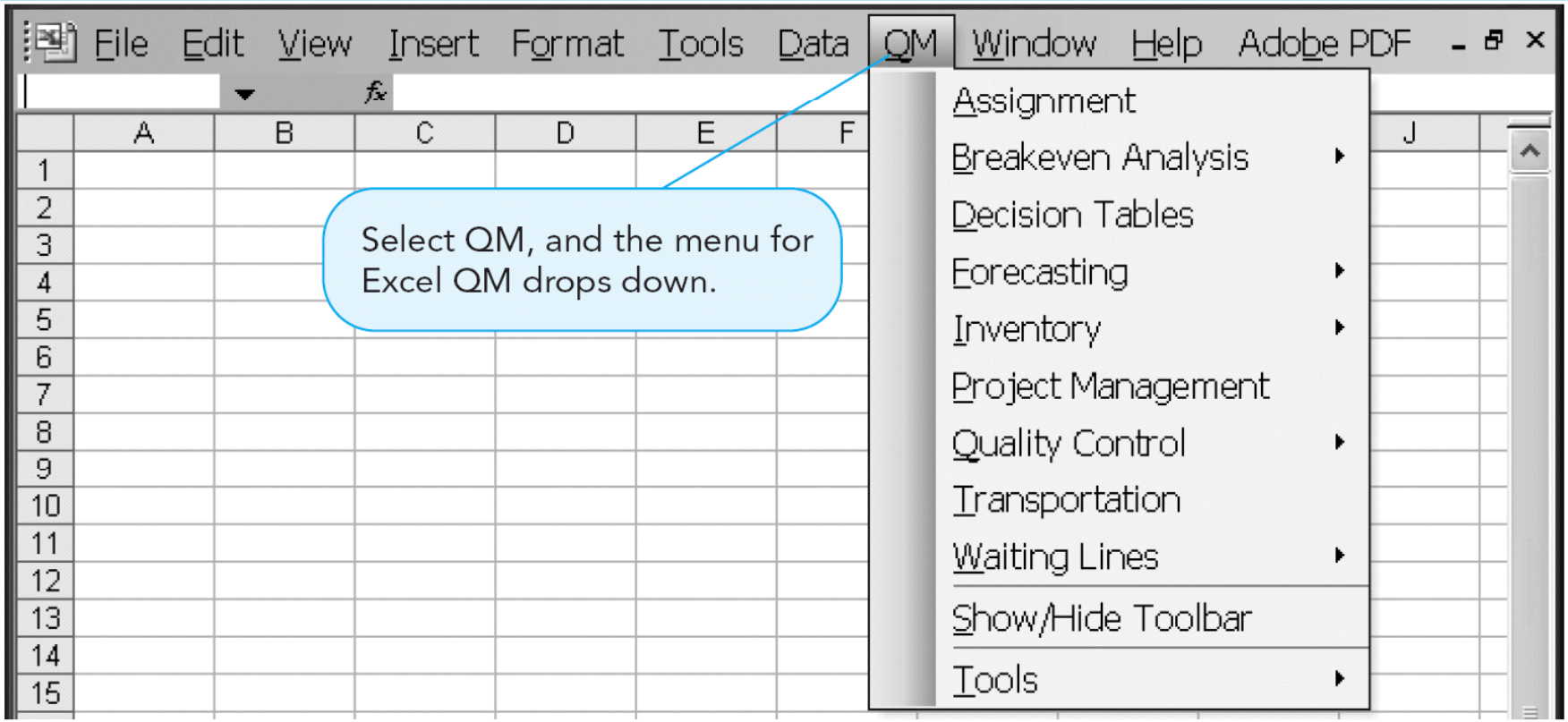


Program 1.1

Computers and Spreadsheet Models

Excel QM's Main Menu (2003)

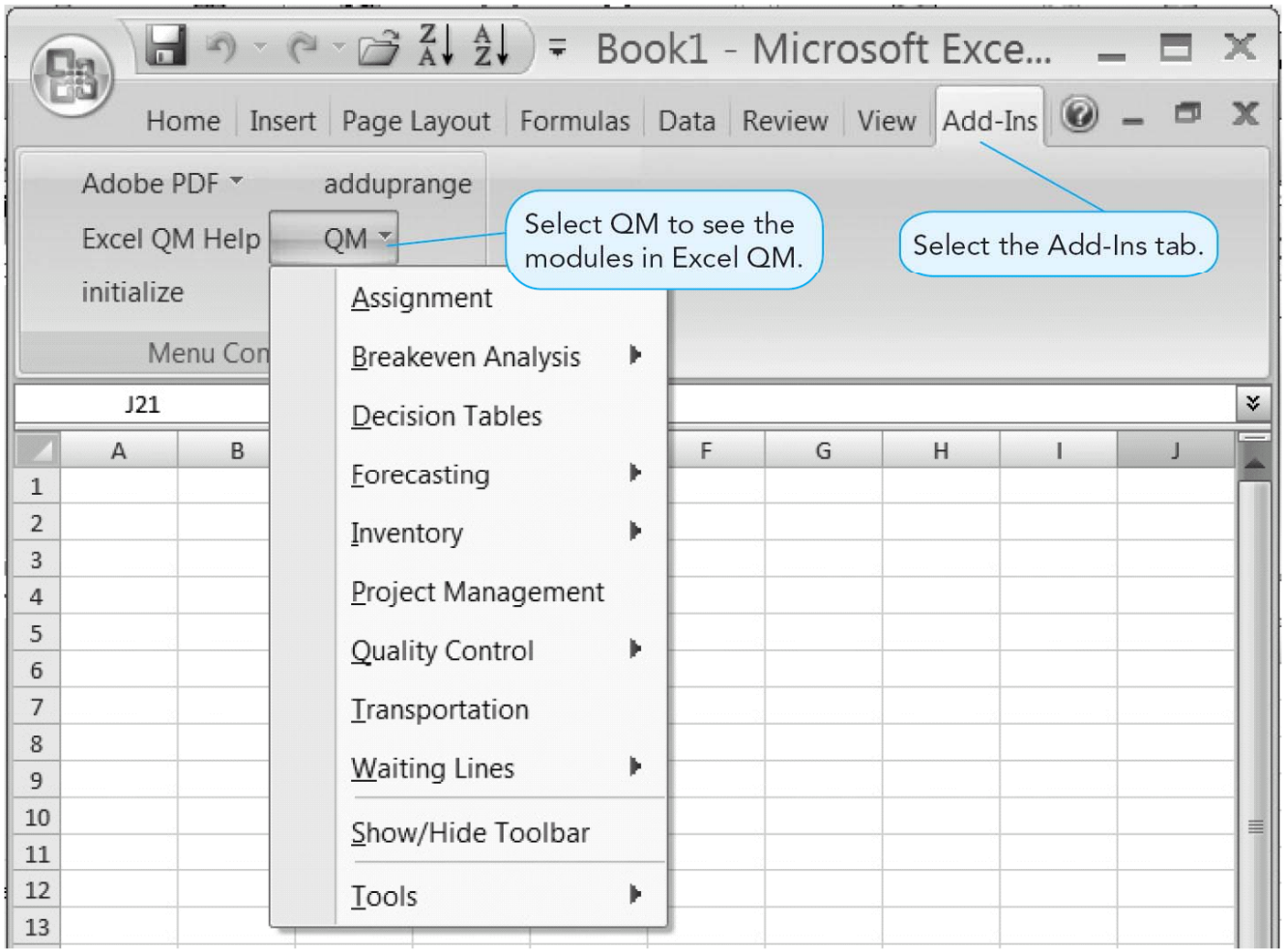
- Works automatically within Excel spreadsheets



Program 1.2A

Computers and Spreadsheet Models

Excel QM's Main Menu (2007)



Program 1.2B

Computers and Spreadsheet Models

Excel QM for the Break-Even Problem

	A	B	C
1	**Pritchett Clock Repair Shop**		
2			
3	**Breakeven Analysis**		
4	**Enter the fixed and variable costs and the selling price in the data area.**		
5			
6			
7	Data		
8		Rebuilt Springs	
9	Fixed cost	1000	
10	Variable cost	5	
11	Revenue	10	
12			
13			
14	**Results**		
15	Breakeven points		
16	Units	=B9/(B11-B10)	
17	Dollars	=B9+B10*B16	
18			
19	**Graph**		
20	Units	Costs	Revenue
21	0	=B9+B10*A21	=B11*A21
22	=2*B16	=B9+B10*A22	=B11*A22

Enter the fixed cost, variable cost, and revenue.

Compute the break-even point in units and dollars.

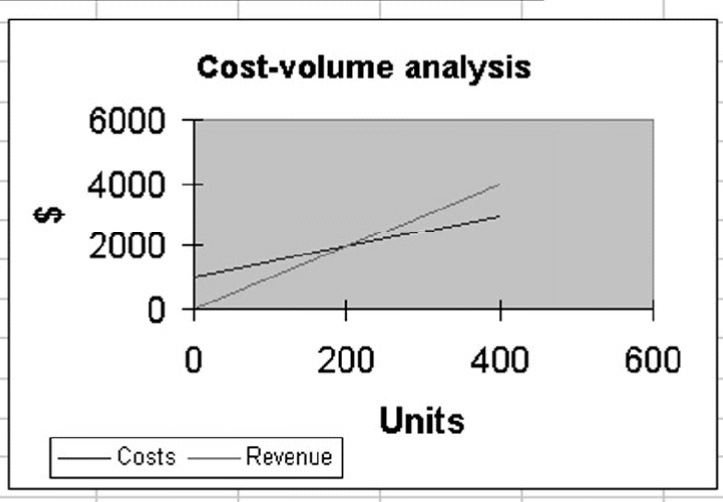
Construct the cost–volume analysis graph.

Program 1.3A

Computers and Spreadsheet Models

Excel QM Solution to the Break-Even Problem

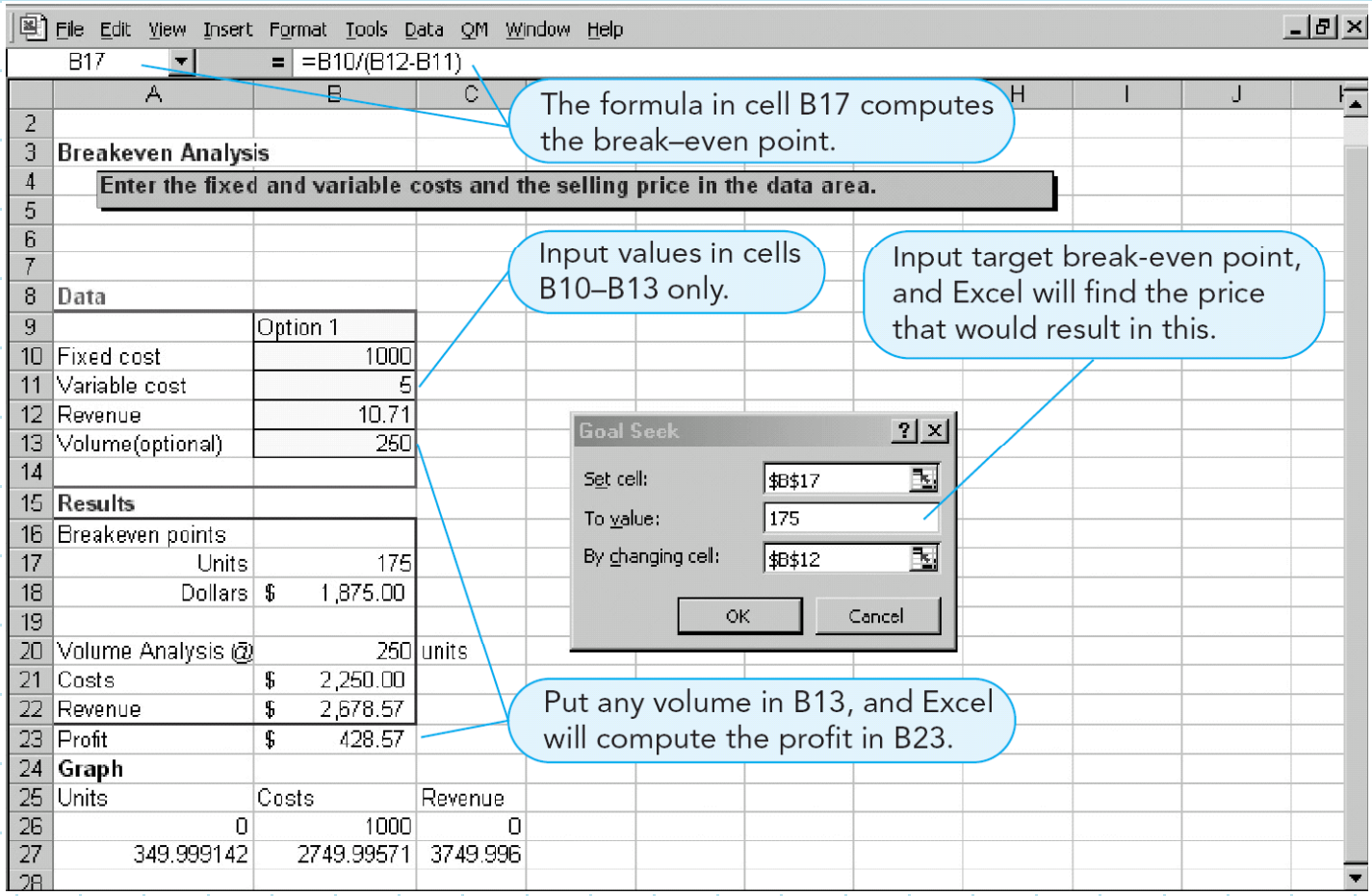
	A	B	C
1	**Pritchett Clock Repair Shop**		
2			
3	**Breakeven Analysis**		
4	Enter the fixed and variable costs and the selling price in the data area.		
5			
6			
7	Data		
8		Rebuilt Springs	
9	Fixed cost	1000	
10	Variable cost	5	
11	Revenue	10	
12			
13			
14	**Results**		
15	Breakeven points		
16	Units	200	
17	Dollars	$ 2,000.00	
18			
19	**Graph**		
20	Units	Costs	Revenue
21	0	1000	0
22	400	3000	4000



Program 1.3B

Computers and Spreadsheet Models

Using Goal Seek in the Break-Even Problem



	A	B	C
2			
3	**Breakeven Analysis**		
4	**Enter the fixed and variable costs and the selling price in the data area.**		
5			
6			
7			
8	**Data**		
9		Option 1	
10	Fixed cost	1000	
11	Variable cost	5	
12	Revenue	10.71	
13	Volume(optional)	250	
14			
15	**Results**		
16	Breakeven points		
17	Units	175	
18	Dollars	$ 1,875.00	
19			
20	Volume Analysis @	250	units
21	Costs	$ 2,250.00	
22	Revenue	$ 2,678.57	
23	Profit	$ 428.57	
24	**Graph**		
25	Units	Costs	Revenue
26	0	1000	0
27	349.999142	2749.99571	3749.996
28			

Program 1.4

Possible Problems in the Quantitative Analysis Approach

Defining the problem

- **Problems are not easily identified**
- **Conflicting viewpoints**
- **Impact on other departments**
- **Beginning assumptions**
- **Solution outdated**

Developing a model

- **Fitting the textbook models**
- **Understanding the model**

Possible Problems in the Quantitative Analysis Approach

- **Acquiring input data**
  - **Using accounting data**
  - **Validity of data**
- **Developing a solution**
  - **Hard-to-understand mathematics**
  - **Only one answer is limiting**
- **Testing the solution**
- **Analyzing the results**

Implementation – Not Just the Final Step

Lack of commitment and resistance to change

- **Management may fear the use of formal analysis processes will reduce their decision-making power**
- **Action-oriented managers may want "quick and dirty" techniques**
- **Management support and user involvement are important**

Implementation – Not Just the Final Step

Lack of commitment by quantitative analysts

- **An analysts should be involved with the problem and care about the solution**
- **Analysts should work with users and take their feelings into account**

Summary

- Quantitative analysis is a scientific approach to decision making
- The approach includes
  - Defining the problem
  - Acquiring input data
  - Developing a solution
  - Testing the solution
  - Analyzing the results
  - Implementing the results

Summary

- Potential problems include
  - Conflicting viewpoints
  - The impact on other departments
  - Beginning assumptions
  - Outdated solutions
  - Fitting textbook models
  - Understanding the model
  - Acquiring good input data
  - Hard-to-understand mathematics
  - Obtaining only one answer
  - Testing the solution
  - Analyzing the results

Summary

- Implementation is not the final step
- Problems can occur because of
  - Lack of commitment to the approach
  - Resistance to change

