INTRODUCTION TO QUANTITATIVE METHODS IN BUSINESS

WITH APPLICATIONS USING MICROSOFT® OFFICE EXCEL®

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Note to the reader: In this Manual the solutions to the odd-numbered exercises for each chapter are preceded by a summary of the requisite material presented in the main text. Hence the numbering of the sections offered herein mirrors those used to designate the various portions of the textbook.

Chapter 1

The Mathematical Toolbox: A Summary

1.2 LINEAR FUNCTIONS

An expression such as $Y = b_0 + b_1X$ represents a *linear equation (function)*, where b_0 is the Y-intercept (it gives the value of Y when $X = 0$) and $b_1 = \Delta Y / \Delta X$ is the *slope* (often referred to as *rise/run*). Here Y is the *dependent variable* and X is the *independent variable*. Note that both b_0 and b_1 are constants.

1.3.1 Solving Two Simultaneous Linear Equations

At times you will need to obtain a solution to a set of simultaneous linear equations, that is, to a set of equations of the general form:

$$aX + bY = e, \tag{1.1}$$

$$cX + dY = f. \tag{1.2}$$

A system such as this is said to be *consistent* if it has at least one solution. Moreover, if $ad - cb \neq 0$, then this equation system is consistent. For instance, the equation system

$$X - Y = 6 \tag{1.3}$$

$$3X - 2Y = 4 \tag{1.4}$$

is consistent since $(1)\ (-2) - (3)\ (-1) = 1 \neq 0$. In fact, to obtain the (unique) solution, we can multiply Equation (1.3) by -3 so as to obtain $-3X + 3Y = -18$, and then add this multiple to Equation (1.4) to get $Y = -14$. If we then substitute $Y = -14$ into Equation (1.3), we obtain $X = -8$. How do we know that we have generated the correct solution to this equation system?

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Answer: Substitute $X = -8$ and $Y = -14$ back into, say, Equation (1.4) and show that equality holds.

It is easily demonstrated that the equation system

$$4X_1 + 2X_2 = 3,$$

$$16X_1 + 8X_2 = 12,$$

is *inconsistent* or *dependent* in that it has no solution. Here $(4)(8) - (16)(2) = 0$. Clearly, these two equations represent parallel lines—they do not intersect.

1.4 SUMMATION NOTATION

The operation of addition of a set of n values is readily carried out by using the "sigma" notation. In this regard, the left-hand side of the expression

$$\sum_{i=1}^{n} X_i = X_1 + X_2 + \cdots + X_n$$

reads: "the sum of all values X_i as i goes from 1 to n." The right-hand side shows that the operation of addition has been executed. Some useful summation rules are as follows:

Rule 1: $\sum_{i=1}^{n} (X_i \pm Y_i) = \sum_{i=1}^{n} X_i \pm \sum_{i=1}^{n} Y_i$.
Rule 2: $\sum_{i=1}^{n} cX_i = c\sum_{i=1}^{n} X_i$, where c is a constant.
Rule 3: $\sum_{i=1}^{n} c = nc$, where c is a constant.

Note also that

$$\sum_{i=1}^{n} X_i^2 \neq \left(\sum_{i=1}^{n} X_i\right)^2,$$

$$\sum_{i=1}^{n} X_i Y_i \neq \left(\sum_{i=1}^{n} X_i\right)\left(\sum_{i=1}^{n} Y_i\right),$$

if $\overline{X} = \sum_{i=1}^{n} X_i/n$ is the sample mean, then

$$\sum_{i=1}^{n} (X_i - \overline{X}) = 0.$$

The *Pearson sample correlation coefficient* can be written as either

$$r = \frac{\sum_{i=1}^{n} (X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n} (X_i - \overline{X})^2 \sum_{i=1}^{n} (Y_i - \overline{Y})^2}} \quad \text{(long formula)},$$

where $\overline{X} = \sum_{i=1}^{n} X_i/n$ and $\overline{Y} = \sum_{i=1}^{n} Y_i/n$ are the sample means of X and Y, respectively; or as

$$r = \frac{\sum X_i Y_i - \frac{\sum X_i \sum Y_i}{n}}{\left[\left(\sum X_i^2 - \left[\left(\sum X_i\right)^2/n\right]\right)\left(\sum Y_i^2 - \left[\left(\sum Y_i\right)^2/n\right]\right)\right]^{1/2}} \quad \text{(short formula)}.$$