

## 11. OVERVIEW OF THE INVESTMENT PORTFOLIO SOFTWARE

*The Investment Portfolio* software was developed by Edwin J. Elton, Martin J. Gruber and Christopher R. Blake, in conjunction with IntelliPro, Inc., to accompany the textbook *Modern Portfolio Theory and Investment Analysis*, by Edwin J. Elton and Martin J. Gruber. The software consists of the following eight "modules": the Markowitz Module, the Performance Module, the Equilibrium Module, the Valuation Module, the Bond Module, the Option Module, the Futures Module, and the Statistics Module. Once the software has been installed, each of the above modules appears as a separate icon under the overall heading "The Investment Portfolio." To run a module, simply click on its icon. Each module contains data files for analysis. You can also import external data for analysis, or enter new data directly into a module. To edit existing data in a module, simply double click on the cell containing the data. In each module, commands can be entered in one of three standard ways common to all Windows programs: by clicking with your mouse on the desired command names that appear along the top of the screen; by holding down the "Alt" key and typing in the underlined letter in the desired command names; or by clicking on the icons along the "toolbar" at the top of the screen. If you highlight a command name by pointing to it with your mouse, a brief description of the command will appear in the lower left corner of the screen. Also, if you put your mouse cursor on an icon, the icon's associated command name will appear just below the icon.

### **The Markowitz Module**

The Markowitz module is designed to find optimal portfolios under various assumptions regarding the variance/covariance matrix of asset returns and the availability of a riskless asset and short sales. The input data can be either in the form of time series of returns or of mean returns, standard deviations, and either correlations or covariances of returns. The output includes a graphical depiction of the efficient frontier, and the mean returns, standard deviations, and the composition of any portfolio you select along the efficient frontier. You can also plot the individual securities and your own "custom" portfolios. See the chapter on the Markowitz Module for details.

### **The Performance Module**

The Performance Module is designed to evaluate the performance of portfolios (e.g., mutual funds) with respect to up to three benchmark indices. The benchmark indices can be in either total return or excess return (total return minus the return on a riskless asset) form. The performance evaluation is done using linear regression. The input data are in the form of time series of returns. The output includes the portfolios' mean returns, coefficients of determination,

alphas, residual variances, and betas. See the chapter on the Performance Module for details.

### **The Equilibrium Module**

The Equilibrium Module is designed to generate either the theoretical or empirical Security Market Line and to allow the user to compare the actual returns of various assets with their equilibrium counterparts. The input data are in the form of user-entered estimates of the returns on the riskless asset and the market portfolio and/or time series of returns. The output includes a graphical depiction of the Security Market Line, the plots of the selected securities around that line, and the actual and equilibrium returns of the selected assets along with their betas. See the chapter on the Equilibrium Module for details.

### **The Valuation Module**

The Valuation Module is designed to value stock prices and/or returns using one-, two- and three-stage growth models. The input data are in the form of forecasted dividends, growth rates, growth transition periods and discount rates (either user-entered or from an input file). The output includes a graph of the forecasted prices or returns period by period, and the user can select points along the graph to view a predicted value at a specific period. See the chapter on the Valuation Module for details.

### **The Bond Module**

The Bond Module is designed to calculate spot rates, forward rates, theoretical bond values, durations, yield-to-maturities and convexities from a set of bond data. It also identifies portfolios that immunize (protect) either user-supplied liabilities or an individual bond (selected from the bond data base) against shifts in interest rates. The input data are in the form of maturity dates, valuation dates, quoted prices, annual coupon rates and accrued interest for various bonds. The output includes graphs of spot, forward and predicted spot yield curves, theoretical bond values, durations, convexities, yield-to-maturities, and the composition of duration-matching portfolios. See the chapter on the Bond Module for details.

### **The Option Module**

The Option Module is designed to graph profit diagrams, value put and call options on stocks and futures, and calculate implied volatilities. The input data

## THE MARKOWITZ MODULE

The Markowitz module is designed to find optimal portfolios under various assumptions regarding the variance/covariance matrix of asset returns and the availability of a riskless asset and short sales. You open the Markowitz module simply by clicking on the "Markowitz Module" icon in The Investment Portfolio group. The input data can be in one of three forms: a time series of prices and dividends; a time series of returns; or a set of estimated mean returns, standard deviations, and either correlations, covariances, betas or a constant correlation coefficient. (See Example 1 below if you wish to input covariances rather than correlation coefficients.) The output includes a graphical depiction of the efficient frontier, and the mean returns, standard deviations, and compositions of any portfolios you select along the efficient frontier. You can also plot the individual securities and your own "custom" portfolios.

Data can be inputted in one of three ways:

- Entered from the keyboard using the "file" and "new" commands to create either an "asset time series", "group time series", "group correlation table", "group single-index table" or a "group constant correlation table" file. See Appendix A, Section 1 (Types of Files) for a detailed description of these files. ("Group multi-index table" files are created by the software from "group time series" files.)
- Selected from provided data bases or user-created files using the "file" and "open" commands. The following files are provided for the Markowitz module: "stock97.ats" (24 stocks), "fund97.ats" (45 mutual funds) and "index97.ats" (14 indexes). See Appendix A, Section 2 (Provided Files) or click on "help" in the module for a detailed description of these files.
- Imported from an external data base using the "file" and "import" commands. See Appendix B (Importing Data) for details.

The Markowitz module can calculate and plot efficient portfolios under any of the following five scenarios:

- Short sales allowed with riskless lending and borrowing at either the same rate or different rates.
- Short sales allowed with no riskless lending and borrowing.
- Short sales not allowed with riskless lending and borrowing at either the same rate or different rates.

- Short sales not allowed with no riskless lending and borrowing.
- "Lintner" short sales allowed with riskless lending and borrowing at the same rate.

Many of the more frequently used commands in the Markowitz module appear as icons along the top toolbar:



open an existing file



save a file



print a file



change assets in a time series



change periods in a time series



change assets in a group table



run the optimizer



plot individual securities



run the editor



show portfolio composition



zoom graph



unzoom graph



copy graph to clipboard



exit module

## Examples

The following examples illustrate how to use the Markowitz module. The first examples involve utilizing means, standard deviations and correlations as inputs. The latter examples utilize time series of asset returns as inputs. To gain a broad understanding of this module's capabilities, you should read each of the following examples in order. For complete coverage of the theory and techniques of Markowitz portfolio optimization, see the chapters "Delineating Efficient Portfolios" and "Techniques For Calculating The Efficient Frontier" in Elton and Gruber's *Modern Portfolio Theory and Investment Analysis*.

### Example 1

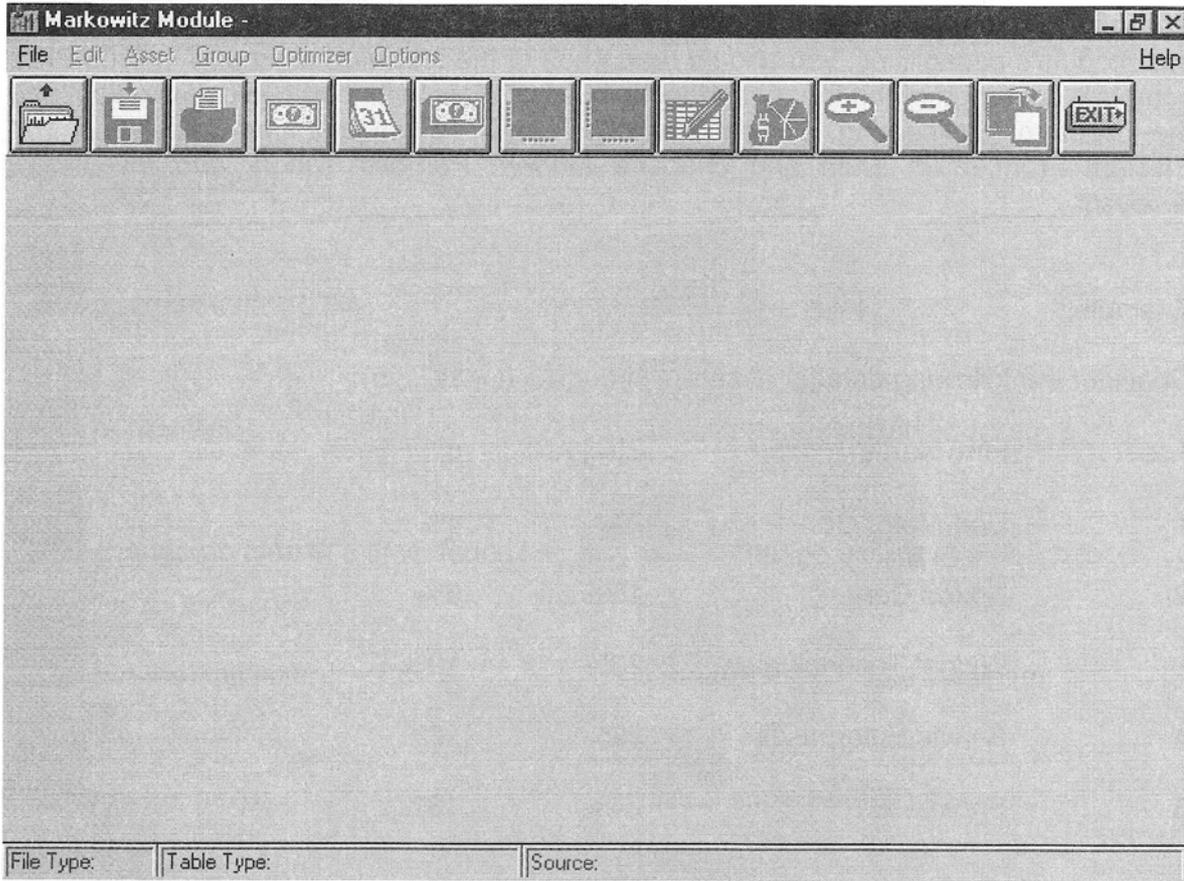
Consider the following data for assets 1 through 5 ( $i = 1, \dots, 5$ ):

Asset i	Firm Name	$E[R_i]$	$\sigma_i$
1	Dorf Motor Co.	8%	4%
2	Roxoff Corpo	15%	6%
3	Widget Technologies	20%	12%
4	Beavis Enterprises	22%	10%
5	Shoki, Ltd.	24%	13%

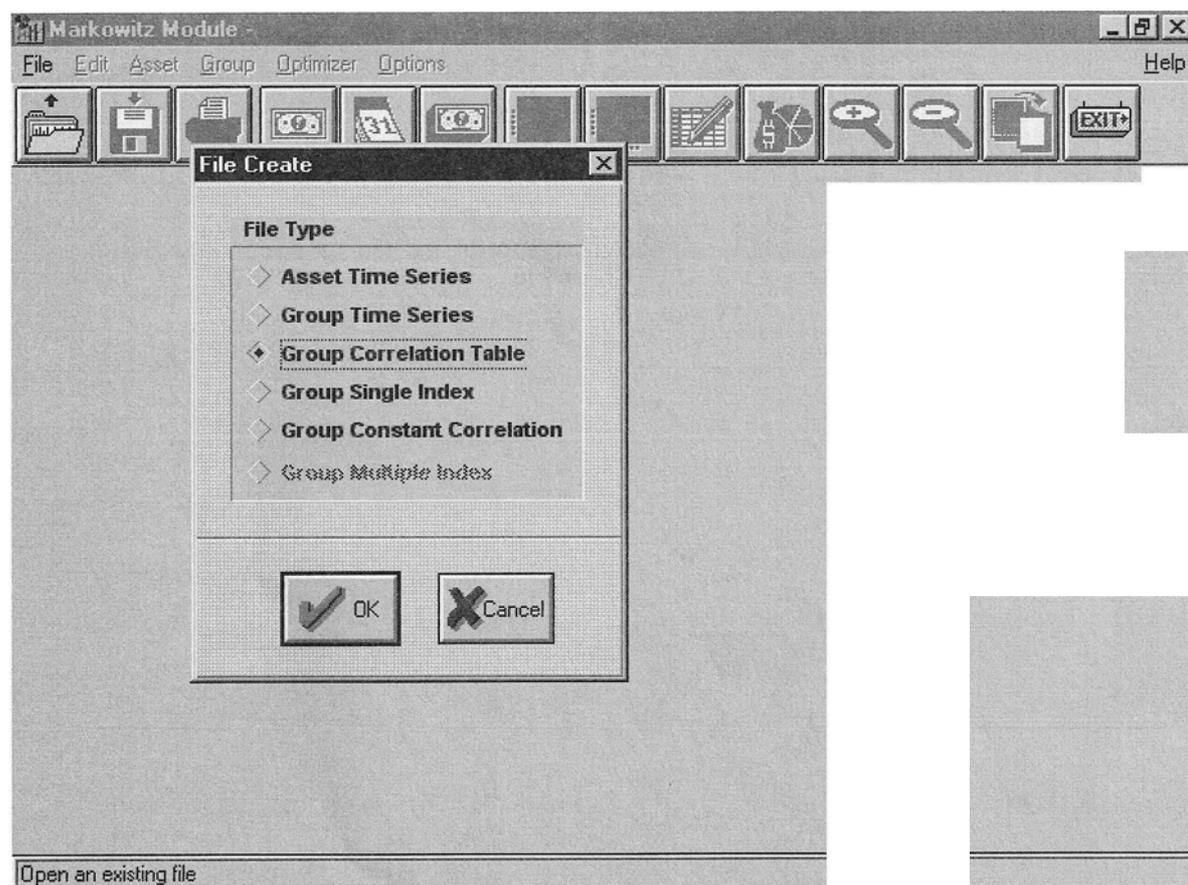
Also,  $\rho_{12} = -0.15$ ,  $\rho_{13} = 0.45$ ,  $\rho_{14} = 0.3$ ,  $\rho_{15} = 0.5$ ,  $\rho_{23} = 0.4$ ,  $\rho_{24} = 0.15$ ,  $\rho_{25} = 0.3$ ,  $\rho_{34} = 0.8$ ,  $\rho_{35} = 0.5$ , and  $\rho_{45} = 0.2$ .

What are the investment weights, the expected return ( $E[R_p]$ ) and the total risk ( $\sigma_p$ ) of the least risky ("global minimum variance" or "GMV") portfolio constructed from the above assets when short sales are allowed and when short sales are not allowed?

The first step in answering this question is to open the Markowitz module. After clicking on the "Markowitz Module" icon and then on "OK" in the "About" window which first appears, you will see the following:



To input the above data, click on "file" and "new" and select "Group Correlation Table" by clicking on the diamond next to those words:



(If you had covariance data instead of correlation data, you would still open up a group correlation table, but then you would click on "Group" and "Covariance table" to get a table for entering means, standard deviations and covariances. If you choose to enter data in this form, you should be sure the standard deviations and covariances have come from a valid distribution or are sample estimates from historical data; otherwise, the numbers you enter may result in some of the corresponding correlation coefficients being invalid, i.e., being less than -1 or greater than + 1. You can check this by clicking on "Group" and "Correlation table" after you have entered the covariances.)