Homework Problem #3
Portfolio Analysis and Value at Risk

APEC 4501 Spring 2009

Objective: **To develop a portfolio analysis of returns and to calculate the Value-at-Risk (VaR).**

Excel features used: statistics functions, Data Tables, Cond. Formatting, Offset, @Risk

<u>Reading:</u> Benninga, Ch. 8 (239-251) and Ch. 15 (397-409); @Risk Manual (on-line), Ch. 4

<u>Assignment (Part 1) - - Portfolio analysis:</u>

Retrieve the Excel spreadsheet **Returns data.xls** from the class webpage. This database contains an historical time series of annual gross returns for four assets: 1) a food industry mutual fund, 2) the S&P500 index mutual fund, 3) the 10-year Treasury note, and 4) Midwest farmland. Using this data you are to take the perspective that you are consulting for a Midwest farmer who is trying to determine how best to invest his/her business profits. **Note:** We will be assuming that these returns are normally distributed random variables. Label this spreadsheet **RETURNS.**

1. Prepare a summary statistics section (mean, median, variance (Varp), standard deviation (Stdevp), minimum, and maximum). Prepare a correlation matrix for those returns using the *Correl* function. Use the Excel statistics functions to do this step. Use the *Frequency* array function to prepare graphs for each of these returns series as shown in Benninga (p. 828-829). **Discuss:** Do these four frequency distributions look normally distributed?

2. Prepare a variance-covariance matrix for each pair of assets using the *Covar* statistical function. Prepare the variance-covariance matrix a second time using the *Offset* function as shown in Benninga (p. 298-299).

3. Prepare tables that show the proportions of assets, the standard deviations, and the means of each two-asset portfolio identified below, where the two-asset portfolio proportions change by 10% increments (0, .10, .20, …, .90, 1.00) and the proportions of the two assets in each portfolio sum to one. Complete the mean-standard deviation tables for each of the portfolios using *Data Tables.* Using this approach prepare separate tables for the following three, two-asset portfolios: 1) farmland and the food industry mutual fund, 2) farmland and the S&P500 mutual fund, and 3) farmland and the 10-year Treasury note. Identify the “minimum variance” portfolio in each table.

4. Prepare graphs that illustrate the “risk efficiency” relationship between the mean returns and the standard deviation of returns for each of the three portfolios in step 3. Identify the “efficient frontier” in each table using the *Conditional Formatting* feature. **Briefly discuss:** What do you observe about the shapes of the graphs and what that implies about the recommendations you would make to the farmer-investor on portfolios to consider based on his/her level of risk aversion?

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Assignment (Part 2) - - Value at Risk (VaR):

As Benninga defines it, "the VaR is the lowest quantile of the potential losses that can occur within a given portfolio during a specified period of time." (p. 397) In this part of the assignment we measure the VaR of alternative portfolios of the assets considered in Part 1.

5. Insert a new spreadsheet and label it **VaR**. Prepare a table in this spreadsheet that reports the distributions of returns for: 1) each of the four individual assets and 2) each of the three, two-asset portfolios developed in step 3 (in this step we will assume the proportions are 0.50 in each asset). Following the example in Benninga (p. 398) you should first create a table of mean and standard deviation of returns for each individual asset and for each two-asset portfolio. Assume an initial investment of 100 and choose an appropriate cut-off value. To complete the table for each asset and for each portfolio, calculate in separate columns the quantile value (the probability under the normal distribution curve) at the 1% level, and the VaR at the 1% level.

   Note: The VaR at 1% is equal to the initial investment amount minus the quantile value at the 1% probability level. To calculate the quantile value, use the *Norminv* function found in the Excel statistics library. To calculate the probability density for each asset use the *NormDist* function.

   Briefly discuss: What do the table results show about the effect of two-asset portfolio diversification on the Value at Risk to the investor?

6. Prepare a table and corresponding graph that illustrates the farmland quantile probability function (the cumulative probability function). Use the *Data Table* command to complete the table. Prepare a second table and corresponding graph that illustrates the farmland probability density function (the noncumulative probability function). For each of these tables and graphs use maximum and minimum cut-off values and sufficiently small intervals in the table to make the graphs look like complete smooth distributions. **Discuss:** How do these graphs compare to the distributions you generated in step 1?

   Repeat this graphic analysis using the portfolio of 50% invested in farmland and 50% invested in the food industry mutual fund. **Briefly discuss:** What do the two two-asset portfolio probability function graphs show about the effect of diversifying the portfolio to include farmland and food industry stocks? How does this compare with your recommendations in step 4?

Assignment (Part 3) - - Simulating portfolio returns:

7. Using the 50% farmland/50% food industry portfolio from step 6, use the @Risk add-in program in Excel to simulate the returns and portfolio value for the farmer and the probabilities of achieving target returns for a 10-year investment horizon. This will involve 2 primary steps. First, fit the historical portfolio returns data to a distribution using @Risk (we will assume it is a normal distribution). Second, use the identified distribution to simulate the portfolio returns, where the farmer's initial investment amount is 100.

   Additional instructions on how to use @Risk to complete Part 3 of the assignment will be handed out and the @Risk tool will be demonstrated in class. In the meantime read Chapter 4 in the @Risk manual for the needed background.