Lab 4:
Bivariate Distributions: Correlation, Covariance and Regression

Objectives:

1. Learning a simple way to download data from web sites.
2. Even more practice with Excel: equations and functions.
3. Concepts of covariance and correlation – variables that are related to each other.
4. Descriptive measures of covariance and correlation.
5. Building a portfolio of stocks: Expected return and risk.

Key Terms:

1. ***Covariance*** and ***correlation***.
2. ***Scatter Diagrams*** / X-Y Graphs
3. ***Portfolio Analysis***
4. ***Expected Returns and Risk***

Data: *Lab 4 – Interest Rates.xls*.

Exercises:

- ***Downloading Data*** *– A simple method.*
  1. Open the Excel file *du jour*: ***Lab 4 - Interest Rates and Portfolio.xls***. (After you've opened the file, save it as ***Lab 4 – your name.xls***.) The file contains several interest rates that I collected from the web site below. In lab, I want you to find and copy data for Corporate Bonds into the spreadsheet.
  2. The web is a great place to find data, especially data of interest to federal agencies. Today we're going to work with various interest rates and the consumer price index. To download the interest rates, open the web site: ***http://www.federalreserve.gov/releases/h15/data.htm***. This web site provides links to a number of data series. (There are even more series if you go "up" a couple of levels to: ***http://www.federalreserve.gov/releases***. But, don't worry about that now.)
  3. Near the very bottom of this table, you should find several series for **Corporate Bonds**. We're going to use **Moody's Seasoned – Aaa** rated bonds. Click on the right most column labeled **annual**. This will open a text file that describes the series at the top and then lists the series beginning in 1976 and continuing through 2008.
  4. To copy these data to Excel, simply block the data by clicking and dragging the mouse over the two columns (years **1976 – 2008**), then **Copy** that selection. Return to the Excel spreadsheet and **create a new worksheet** titled **Corporate Bonds – Aaa**. Click on cell A2 in that new worksheet (leave A1 open for a label) and the **Paste** the data. (To paste the data, try "right-clicking" in cell A2, choose "**Paste Special…**" and select "**HTML**" or "**Unicode Text**." Excel may treat these as two columns of data. If not, Excel will treat the two columns of data as one column of text and puts them into column A.
  5. If your data do not come in as two columns: **Don't click anywhere else! While the entire column of data is still highlighted, click on the "Data" tab, then find "Text to Columns"** near the center of the ribbon. A "Wizard" is opened to help you convert text to data. Excel asks you to: **Choose the file type that best describes your data**. You'll note that your data are separated (delimited) by a comma, so choose: **Delimited** (it should already be selected). Then, click **Next**. The next screen that appears let's you choose the way the data are delimited – you need to check the box next to **Comma**. Excel will show you how it's going to set up the columns by inserting column breaks. Click **Next** and be sure that the **Column data format** is **General**. Click **Finish** and you're done.

- ***Covariance and Correlation***
  1. Copy your column of bond data to the cells highlighted in green in the worksheet titled "**All Rates.**" ***Use Excel functions to determine the means and standard deviations for these sample data***.
  2. Create an XY scatter diagram for the two variables CD Rate and Bond Rate. What do you observe? Are the variables correlated? What would you guess for the correlation coefficient?

3. Click the **Data** tab, then choose **Data Analysis** and **Covariance** to calculate the covariances for all variables in the table, including the CPI (Consumer's Price Index). Use **Data Analysis** to create a table of correlation coefficients as well. Excel provides a table or matrix of results showing pair-wise covariances or correlations. Review the correlations; a correlation coefficient of –1 is perfect negative linear association, a correlation of +1 is perfect positive linear association, and a correlation coefficient close to 0 means virtually no linear association. What measure, covariance or correlation, would you use to describe linear association among variables? What do you conclude about the relationship between the variables? Which two variables are most closely associated?

♦ ***Portfolio Analysis.***

1. Suppose you want to build your own portfolio. I gathered historic adjusted closing stock prices for 3 stocks: Honda Motor Company, Archer Daniels Midlands and Merck for the period January 2, 2007 through March 2, 2007 from: http://finance.yahoo.com/ . They are in the worksheet ***Stocks***.
2. Go to the Yahoo Financial website and collect data for a stock in which you are interested for the same period. You'll need the stock symbol, or just start typing the name and see if Yahoo can identify the symbol. Once Yahoo gives you the quote, you can then choose "Historical Prices" at the left. Enter the start and end dates and then scroll to the bottom. Yahoo will download the data to an Excel spreadsheet.
3. First, we need to make some assumptions about our portfolio. How much will we invest? How will we distribute our investment across the three stocks? We are going to invest $1,000 in our portfolio. To begin, we'll assume equal weights, but with the beauty of Excel, we'll be able to consider the Expected Return/Risk tradeoffs we face by varying the weights.
4. We're going to invest $1,000 in our portfolio. We could invest all our money in one stock. If we did that, how many shares of each stock could we buy on Jan. 2, 2008? **Calculate the number of shares in the first cell under Shares**. Now, track the **value of the $1,000 invested in that stock** from Jan. 2, 2008 through Feb. 13, 2009. Hold the number of shares constant and let the changing prices cause the value of the investment to change.
5. **Calculate the return on your $1,000 invested for each day**. Just subtract your original investment of $1,000 from the value of the investment on that day.
6. **Create a line graph that shows how your stocks are doing.** To compare on an equal basis, plot the values of the investments for each stock. Use the **Line** chart found on the **Insert** ribbon.
7. **We need some summary measures.** Calculate the expected returns and the standard deviations for the four stocks. Place these summary measures in the worksheet **Portfolio Returns and Risk**. Use Excel functions for the mean and standard deviation. We have all prices for the period Jan. 2, 2008 through Feb. 13, 2009, so you can use the population standard deviation. To create a measure of portfolio risk, we'll also need the **covariances for the stocks. Use the Data Analysis tools to generate a covariance table for all four stocks (my three, plus yours).**
8. **Portfolio Returns:** Portfolio returns are determined by combining a number of stocks with weights that sum to 1.000. Combine the three stocks Honda, ADM and Merck with equal weights, each would have a weight of 0.333. Importantly, the sum of the weights must equal 1.000. Put the weights in a column next to the individual stock returns. That will allow you to see the impacts of changing the weights later. The formula for portfolio expected return is:

$$E[P] = w_1E[X_1] + w_2E[X_2] + w_3E[X_3]$$, **where** X_1 ***are Honda returns, etc.***

9. **Portfolio Risk:** Use the same weights with the variances and covariances for the stocks to determine the portfolio risk. The portfolio risk formula includes the individual variances and covariances and the weights for each stock. Be careful computing the portfolio risk; it is easy to grab the wrong cell references. The formula for risk is:

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + w_3^2\sigma_3^2 + 2w_1w_2\sigma_{12} + 2w_1w_3\sigma_{13} + 2w_2w_3\sigma_{23}}$$

10. **Now review your results.** What happens to the portfolio expected returns and risk when you change the weights? Are there any trade-offs? What factors come into play when making your choices? Given these analyses, what weights might you choose? What would this say about your "preferences?"