University of Texas at Dallas
School of Management

Finance 6310 — Professor Day
Investment Management — Spring 2008

Estimation of Systematic and Factor Risks
(*Due April 1*)

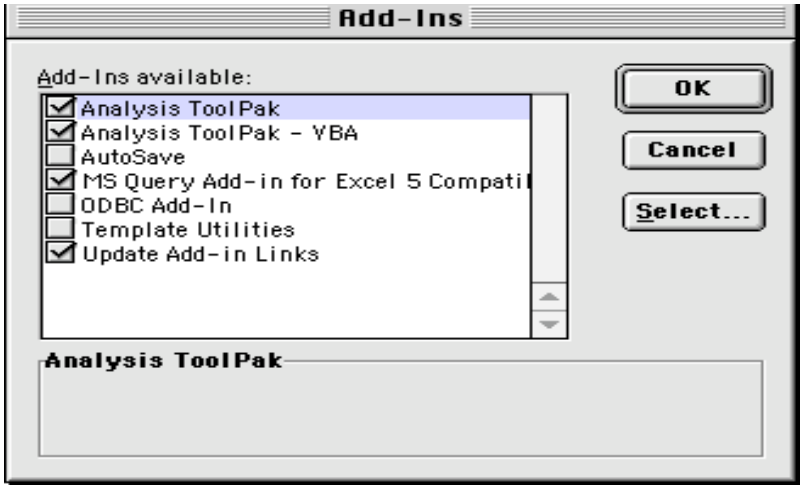
This assignment requires you to perform a series of exercises involving the estimation of systematic risk (*beta*), factor risk, and residual risk for: Google Inc (GOOG), Koninklijke Philips Electronics NV (PHG), and Pfizer (PFE). In addition to computing average weekly returns, betas, factor exposure, and residual standard deviations for the returns on these stocks, you are required to examine the stability of these parameter estimates across two non-overlapping *1-year* periods. A detailed description of the specific (step-by-step) requirements is included at the end of this document. The remainder of this note provides a brief tutorial on using Excel to complete the assignment.

The required data are available on my Web page. To download these data to your computer, click on "*Stock Price Data for the Estimation of Beta and Factor Risk*" in the Spreadsheet Exercises Section of the Web page. As you click on the highlighted link, a menu will appear, allowing you to scroll down to "*Save this link as…*". Select "***Save this link as…***" and you will be prompted to input the location where you wish to store these data and the name that you wish to apply to the downloaded file stored in Excel (for the Mac) Worksheet format. Your computer will then copy a file named Factors08.xls to a file folder of your choice. To avoid problems during the estimation phase of the exercise, immediately convert the file to an Excel Worksheet using the **Save As** command. Once you hit the "Save As" command, you will be prompted with a box that allows you to simultaneously rename the file and alter the file format. In the box "Save As" you should enter the new name that you wish to assign to the file. Under the box "Save File As Type:" you should select one of the Excel Workbook or Excel Worksheet formats. Then click the save button and the original file will be converted to an Excel format.

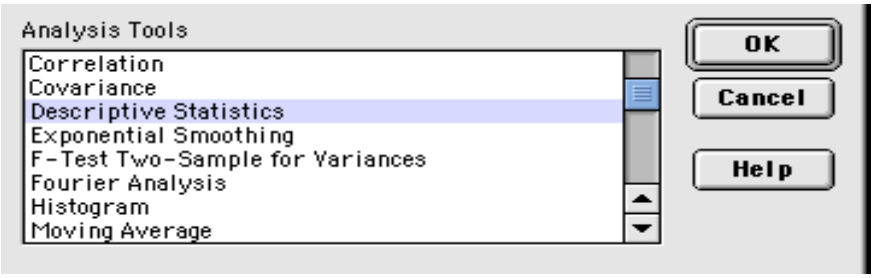
The spreadsheet file includes two worksheets. The worksheet "Prices" stores weekly stock prices (adjusted for stock splits/dividends) for 2006-2007 downloaded from the "Yahoo! Finance" web site. These prices were used to compute the weekly returns stored in the worksheet "Factor and Stock Returns". This second worksheet includes eight columns with two years of weekly returns data. Columns F through H respectively contain two years of weekly returns for GOOG, PHG, and PFE. Column B contains the weekly excess returns ($R_M - R_F$) for a value-weighted portfolio including all NYSE, AMEX, and Nasdaq firms. Columns C and D respectively contain the weekly returns for the Fama/French firm size and book-to-market factors, while column E contains the weekly return for a short maturity U.S. Treasury bill. The weekly return to the firm size factor reflects the difference in the average weekly returns for three value-weighted portfolios including firms having below-median market capitalization and for three value-weighted portfolios including firms having above-median market capitalization, where firms are sorted into the respective portfolios according to their ranking based on market equity capitalization. The book-to-market factor reflects the difference between the average weekly returns for the one-third of firms having the highest ratio of book value to market value and the one-third of firms having the lowest ratio of book value to market value. These factor returns were obtained from Ken French's web site. ***You are required to compute and compare summary statistics for the weekly returns on the value-weighted market return, with the summary statistics for the weekly returns to the firm size and book-to-market factors. In addition, you are required to estimate the systematic (beta) risk, factor risk (firm size and book-to-market), and the residual risk for each stock.***

Computing Summary Statistics for the Data:

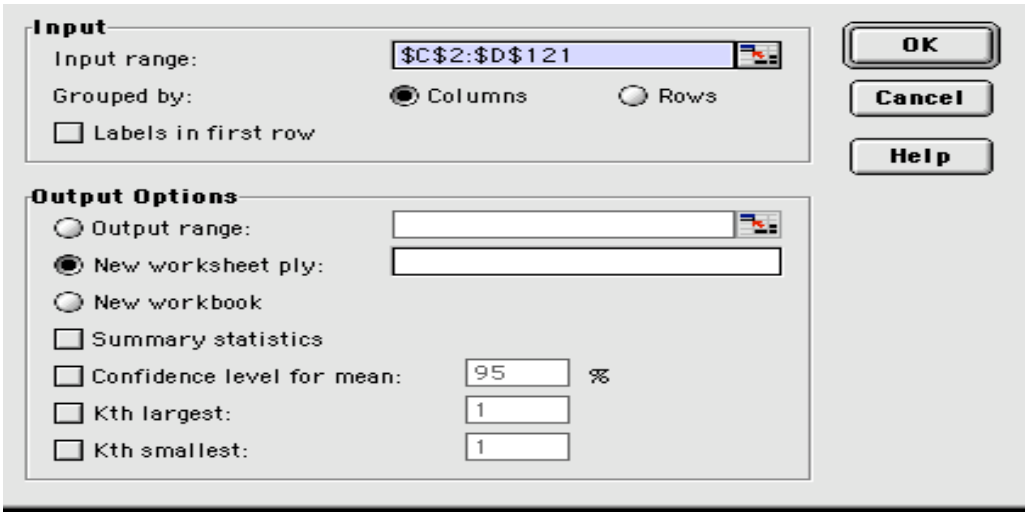
To analyze the return data in your EXCEL spreadsheet, you will need to select the **Data Analysis** function under the Tools menu in your spreadsheet. If Data Analysis is unavailable, select "**Add-Ins**" under the **Tools** menu. Then "check" the box next to the "Analysis Tool Pack". This should give your spreadsheet access to **Data Analysis**, which includes the **Descriptive Statistics** and **Regression Functions** that you need to complete this exercise.



To compute average monthly returns and standard deviations for each return series, select "**Data Analysis**" (or Analysis Tools for earlier versions of Excel) under the "Tools" menu. When the menu of Tools for Data Analysis appear on the screen, select "**Descriptive Statistics"**.



A screen then appears to prompt you for the information Excel needs to compute summary statistics for your data. In the "Input Section" of the box, input the range of values for which you wish to compute summary statistics and check the "Summary statistics" options in the Output Options section of the window. For example, to compute the average weekly returns and standard deviations for the firm size and book-to-market factors stored in columns C and D input the range **C2:D106** to indicate that there are 105 observations for each weekly return series, running from cell C2 through cell D106 (you could compute summary statistics for all seven weekly return series by entering the range **B2:H106)**. You should also **click on columns,** to let Excel know that the monthly returns for each return series are included within a single column, as well as the **Summary statistics box**, to let Excel know that you want a report on the summary statistics for the data.



Estimating Systematic Risk:

The output section on your screen controls where the regression output is stored. Select either **Output Range** and enter the desired position for the "top left cell" of a vacant range of cells where Excel can deposit your output, or else select **New Worksheet Ply** to tell Excel that you want your output to be placed in a separate worksheet. You must also check the box next to **Summary Statistics** so that Excel will know exactly which descriptive statistics you need. Once you have made your selections, click on **OK** and Excel will compute the descriptive statistics that you have requested. Remember that the first cell of the Input Range should be the first data point that you wish to include in your summary statistics. It should not be a blank cell or a cell containing text.

The *CAPM-based* approach to estimating betas assumes the relation between a stock's return and the return on the value-weighted market portfolio (the "market" proxy) stored in column B is

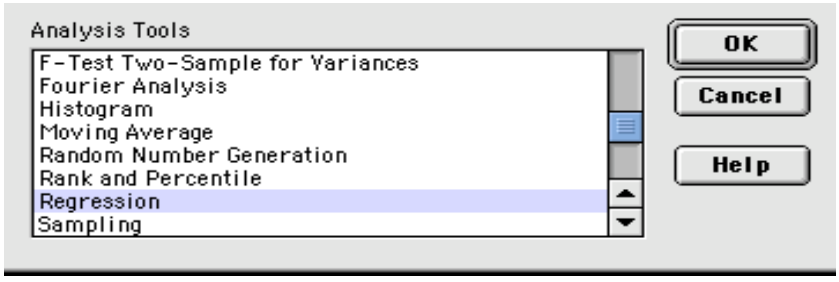
$$R_{Stock} - R_F = a + b\,[\,R_{Market} - R_F\,] + \varepsilon$$

The regression coefficient *b* can be used as an estimate for the stock's beta or systematic risk. Note that although the Capital Asset Pricing Model implies that beta should be estimated by regressing "excess stock returns" (i.e., the return on the market net of the risk-free rate) on the excess returns for a market proxy as shown above, in practice the more traditional ***Market Model***, which involves regressing raw returns for the stock on the raw returns for the market

$$R_{Stock} = a + b\,R_{Market} + \varepsilon$$

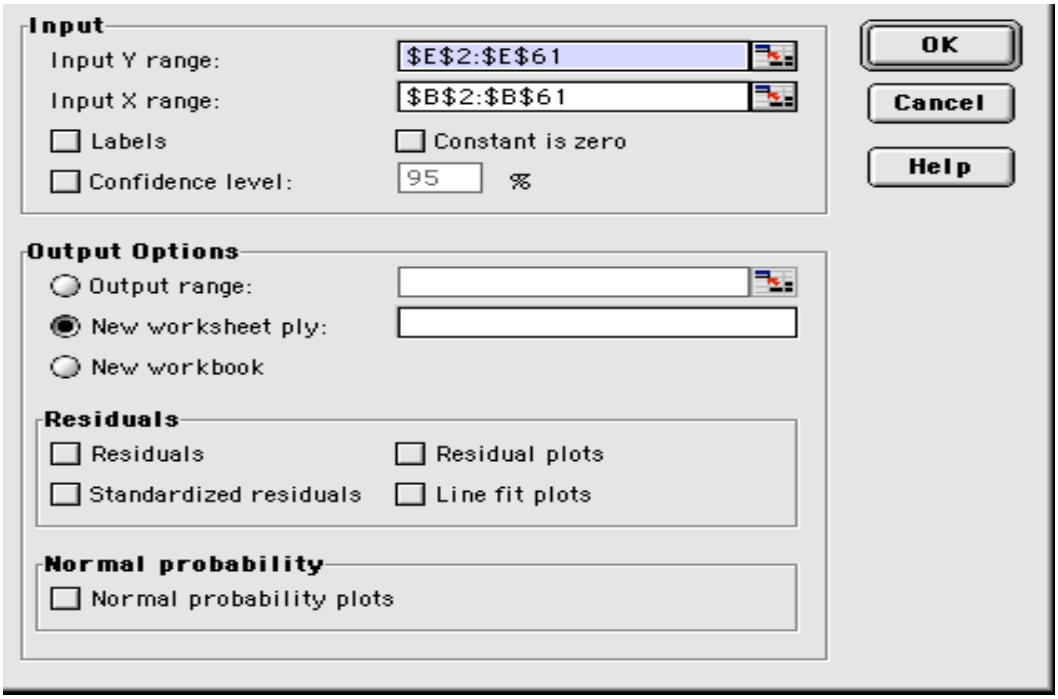
gives virtually identical estimates of beta (usually to the 3rd or 4th decimal point).

To estimate the beta for a given stock, first select **Data Analysis** under the **Tools** Menu. Then select **Regression** from the menu of Analysis Tools.



Excel then prompts you to input the cell ranges for the dependent and independent variables for the regression. Whenever we use a regression package (like Excel) to estimate the systematic risk (beta) for a stock, we are essentially attempting to explain the variation in the periodic returns on the stock using the variation in the returns for a market index (or proxy for the "market"), subject of course to the constraint that the relation between the two return series be linear. Therefore, the dependent variable for your regressions will be the weekly returns for one of the three stocks stored in columns F through H. Input the range of values for the dependent variable in the box titled "**Input Y Range**".

We can illustrate this Excel application by estimating the beta for GOOG over the first *1-year* sample period. The range of cells entered in the Input Y Range box should be "F2:F53" telling EXCEL to use the 52 weekly returns stored in the cells ranging from F2 through F53.



In the "Input X Range" box, input the range for the independent variable (weekly excess returns for the value-weighted market portfolio proxy). The first data point (weekly return) for this market proxy is stored in cell B2. To estimate the market beta for GOOG during the first year in the sample, enter B2:B53 in the **Input X Range** box. Remember that the number of observations included in the Input Y Range and Input X Range boxes must be equal. Then select the cells or worksheet in which to store your output, click **OK,** and Excel will estimate the beta for GOOG. The Regression output reports the beta estimate as the regression coefficient for "**X Variable 1".** ***Note if you also select the box labeled 'Residuals', Excel will save the regression residuals, which can then be used to estimate the properties of GOOG's firm-specific returns.***

You will also be required to estimate betas for both of the *1-year* periods included in the sample. For example, to estimate GOOG's beta for the second *1-year* period in sample, enter F54:F106 in the Input Y Range box and B54:B106 in the Input X Range box. Note that the first cell in the Y range must be the first data point that you wish to use in your regression. It should not be a blank cell or a cell containing text.

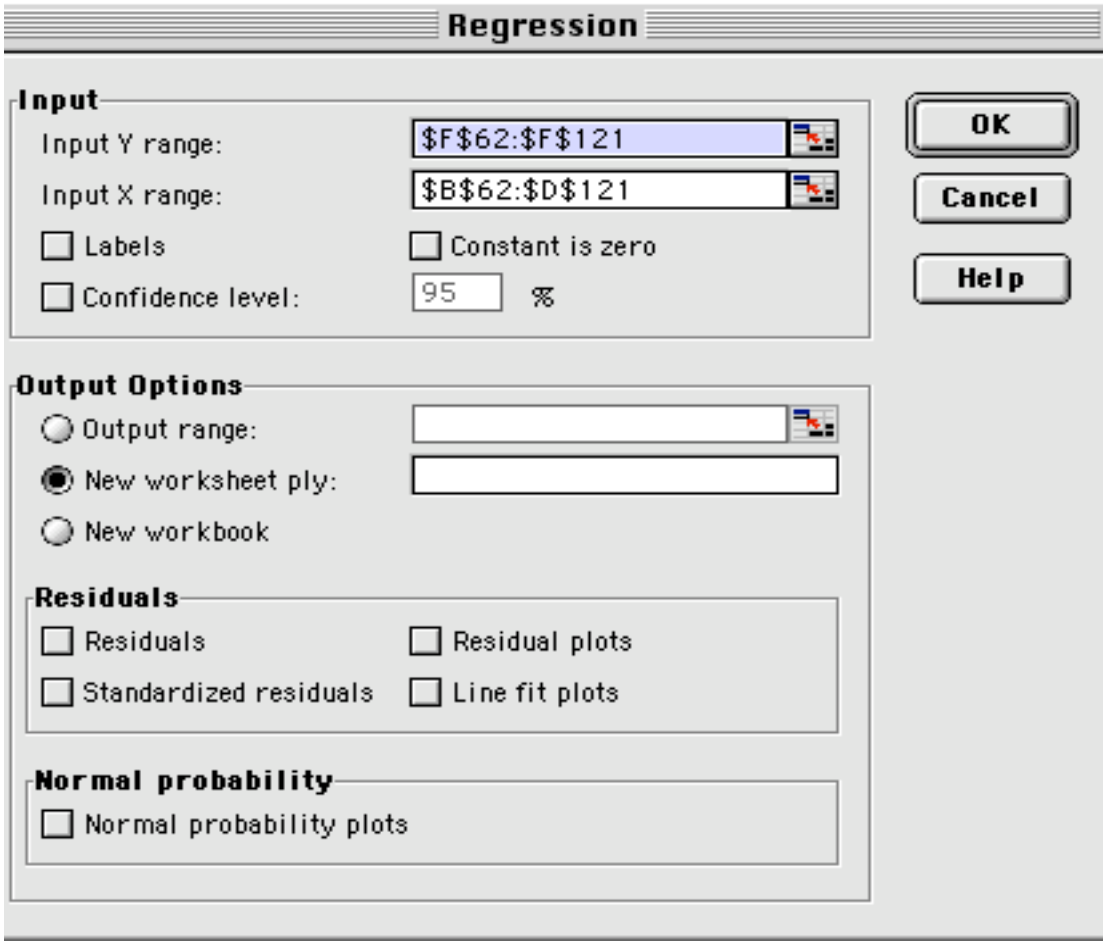
Estimating Factor Sensitivities:

The Fama and French study shows that portfolio exposure to financial factors such as firm size and book-to-market ratios have been important in explaining cross-sectional differences in returns. To estimate the exposure of an individual stock to these factors, we run a regression of the form

$$R_{Stock} - R_F = a + b_1 [R_{Market} - R_F] + b_2 \lambda_{SZ} + b_3 \lambda_{BM} + \varepsilon$$

where λ_{SZ} and λ_{BM} represent the monthly returns to the firm size factor and the book-to-market factor, while b_2 and b_3 are the stock's respective factor sensitivities (exposures) to these factors.

To estimate the factor sensitivities for the stocks in our sample, we expand the range of the independent variables for the regression to include the weekly factor returns stored in Columns C and D. Follow the same procedures used to estimate beta by selecting ***Data Analysis*** from the ***Tools menu,*** and then selecting ***Regression*** from the ***Data Analysis menu***. Once the Regression control box is displayed type in the range of monthly stock returns for the stock whose factor sensitivities that you wish to estimate. For example, to estimate the factor sensitivities for GOOG during the second *1-year* sub-period in the sample, type the cell range **F54:F106** into the Input Y range: as shown below. Then input the cell range **B54:D106** into the Input X range: box in the control panel. The regression control box is illustrated below.



Estimation Assignment:

You are required to provide a summary of your statistical analysis for each of the following questions. ***Do not under any circumstances include a print-out of the data*** with your analysis.

1. Compute the means and standard deviations for the weekly excess returns for the value-weighted market proxy, the firm size factor and the book-to-market factor. Annualize these statistics by multiplying the average weekly returns by 52 and multiplying the weekly standard deviation by $\sqrt{52}$. Compare the annualized mean returns and standard deviations for these factors with one another, as well as with the historical estimates for the risk premium and yearly standard deviation for the "market" reported in your textbook [**Hint: Asking where these data can be found is evidence that you haven't done the assigned reading**.].

2. Use the 52 weekly returns included in the second *1-year* sub-period (the data in rows 54 through 105) to ***estimate the beta, the weekly firm-specific returns for each stock, and the annualized residual standard deviation for each stock*** (i.e., regress the weekly returns for each of the three stocks on the weekly excess returns for the market proxy stored in column B). If you are careful to check/select the box labeled 'Residuals' located in the regression control box, Excel will automatically save the regression residuals, which can then be used as a proxy for each stock's firm specific or residual returns. Later in the assignment, you will be asked to estimate the correlation between the firm-specific (residual) returns for the three stocks in our sample. **[Hint**: The weekly residual standard deviation is the "Standard Error" from the Regression Statistics section of your regression summary output. Alternately, the annualized residual standard deviation may be computed by dividing the residual sum of squares (SS) from the regression by the residual degrees of freedom (N-2 in this case), taking the square root, and then multiplying by $\sqrt{52}$.]

3. Compare the estimated yearly standard deviation for each stock with the implied volatility for the at-the-money call option expiring in January 09. [Hint: Call option prices may be obtained from the Wall Street Journal, Yahoo's Financial web site, or any source of your choosing. You may download an Excel template for valuing options using the Black-Scholes model from the 'Frequently Asked Questions' on my website, "What is an implied volatility?" Once you have downloaded this template, determine the number of days until the option expiration on the third Friday of January 2009, obtain current price quotes for the stock price and call option, as well as an estimate for the risk-free rate. Then keep changing the volatility input in the spreadsheet template (or else use Goal Seek) until the Black-Scholes model price matches the market price of the call option.]

4. Estimate the betas for the three stocks in the data set during the first *1-year* sub-period included in the sample (the data in rows 2 through 53). Compare these estimates of beta and residual standard deviation with the betas that you estimated for the second *1-year* sub-period in problem 2. Discuss any differences between the estimated betas and residual risk for the first half of the sample period relative to your estimates for the second half.

5. Compare your estimates of beta from problem 2 with the estimates of beta reported at ***quote.yahoo.com***. [Hint: Go to the Yahoo Finance web site, input the ticker symbol and retrieve a stock price quote, then click on the ***profile*** link under the stock price quote to find Yahoo's estimate of the stock's beta.]

6. Paste the firm-specific residual returns that you estimated in problem 2 into three adjacent columns in your spreadsheet (recall that these estimates of residual returns are a byproduct of estimating the beta's for the three stocks in the sample). Then use the **Correlation** function available in the **Data Analysis** Tools to compute the sample correlations for your estimates of residual return. Carefully explain whether the estimated correlations are consistent with the Capital Asset Pricing Model assumption that residual returns are uncorrelated. If you find that the residual correlations are not consistent with the Capital Asset Pricing Model, try to provide an explanation as to why the residual returns for these stocks might have non-zero correlations.

7. Estimate and compare the betas and the factor sensitivities for each stock during each of the two *1-year* sub-periods. In particular, consider the statistical significance of the size and book-to-market factors, the impact of including the returns to firm size and book-to-market in the regression on your estimates of beta, and the stability of your estimates of each stock's factor sensitivity across the two *1-year* sub-periods.

8. Many research services (e.g., Value Line and Merrill Lynch) use a forward-looking approach to estimate betas, adjusting estimates of beta obtained using ordinary least squares regression for the observed tendency for estimates that are greater (less) than one to be overestimated (underestimated) using an adjustment such as

$$\hat{\beta}_{Forecast} \quad = \quad 0.35 \quad + \quad 0.65 \times \hat{\beta}_{Historict} .$$

   Use the formula given above to provide adjusted forecasts of beta based on your estimates of beta for the second *1-year* sub-period included in the sample (from problem 2). Compare these adjusted estimates of beta with the respective estimates that are provided by 'Yahoo Finance'.

9. Use the returns for GOOG and PHG to compute the weekly returns for a portfolio that is rebalanced each month to hold 40 percent in GOOG and 60 percent PHG. Put the weekly returns for this portfolio in column I (e.g., if the initial weekly returns for GOOG and PHG are respectively in cells F2 and G2, you should enter the following formula in cell I2)

$$= 0.40*F2 \quad + \quad 0.60*G2 \quad .$$

   Copy the formula to cells I3 through I105. Then estimate the portfolio beta for the second *1-year* sub-period and explain whether the portfolio beta is greater or less than a weighted average of the individual betas

$$.40 \times \hat{\beta}_{GOOG} \quad + \quad 0.60 \times \hat{\beta}_{PHG} 0 \ .$$