Kellogg School of Management, Northwestern U, Department of Finance

FINC 460-0-81 Winter 2012
Investments Akash Bandyopadhyay

First Class Assignment (100 Points): Due on First Lecture

Instructions: This problem set is designed to help you review the course prerequisites. It is ok if you cannot do all parts, but I encourage you to think about them as you prepare for the course. If this problem set seem tremendously hard or impossible then please contact me for a meeting at least 2 days before the first lecture.

The questions on statistics and regression analysis may seem dry, but they are very important for us because statistics is the toolbox for making successful financial investments. A set of supplementary readings on statistics, probability, and regression analysis are posted in the following website:

http://www.kellogg.northwestern.edu/faculty/bandyopadhyay/courses/

Those articles are reasonable resource to review the material but they might not cover everything you need to know. If you need additional help then look-up the relevant materials from prerequisite statistics courses, textbooks, class-notes, online search, or consult with your colleagues.

This problem set is required (that is, mandatory) and it will be graded, but your score on this problem set will not be counted to compute your course grade (with one exception: if you do not turn-in this assignment then I will be inclined to assign you a lower course grade). However, in case your course performance is very close to the borderline between two letter grades and you did well in this assignment, then I may consider assigning you the better grade. Therefore relax, your score on this assignment may improve your letter grade marginally, but it will never hurt your course grade.

This assignment is due individually at the beginning of the first lecture. If you cannot make it to the first class then you have two options. First, you can type up the solution and e-mail a PDF file to me. My e-mail is: a-bandyopadhyay@kellogg.northwestern.edu. Second, you can put the hardcopy directly in my mailbox located at Jacobs Center room 401. I will distribute the solutions of this problem set after the first lecture. Thus no late submission will be accepted.

Let's get started!

1. (5 Points): Define a 'common stock' issued by a corporation, a 'treasury bond', and an 'option' (call or put, European or American style) on a traded stock. What are the differences between a 'treasury bond' and a (equivalent in terms) 'corporate bond'?

2. (10 Points): What are the major differences between the 'open-end funds' and the 'closed-end funds'. Are the 'closed-end funds' structurally the same instruments as the 'exchange-traded funds' (ETF)? How does a 'mutual fund' differ from a 'hedge fund'?

3. (5 Points): Define what it means to 'short-sell a stock'.

4. (5 Points): Equity holders receive dividends from the issuing corporation. Dividend payments affect the stock price. In this question you will calculate the ex-dividend share price of a common stock. You may assume that there is no tax or transaction costs in the market, the equity holders receive a dividend as soon as the corporation announces it, and all market participants share a common set of information/news.

Suppose the common stock of 'ABC Inc.' was trading liquidly at $99.00 per share just before a $1.00 per share dividend is announced by the corporation. When all other information and the existing market condition remain unchanged, what will be the fair price of ABC Inc. common stock per share as soon as the dividend is paid? What is the economic reason for the price change?

5. (5 Points): Solve for *x*, *y*, and *z* from the following set of linear equations:

$$\begin{aligned} 2x + 3y + 4z &= 20 \\ 3x - 5y - 2z &= 17 \\ 4x + 5y - 3z &= -2 \end{aligned}$$

6. Following two parts of this problem are not related to each other.

A. (5 Points): What are the formulas to simplify $(a+b)^2$, $(a-b)^2$, and $\left(a^2 - b^2\right)$?

B. (5 Points): Suppose *x* is a real number. What is $+\sqrt{x^2}$, and why?

7. (5 Points): Consider the following linear equation relating the variables *x* and *y*:

$$x - \sqrt{3}y + 3 = 0$$

What is the 'geometric figure' is been represented by this equation? What is the slope of this straight line? What is the straight line's *x*- and *y*- intercepts?

8. (10 Points): Consider three random variables *X*, *Y*, and *Z*. Suppose they are related by the following linear relationship:

$$Z = 4 + 3X - 2Y$$

It is known that $E[X] = 1$, $E[Y] = 0$, $\text{var}[X] = 4$, $\text{var}[Y] = 9$, and $\text{corr}(X, Y) = -0.125$. Calculate $E[Z]$, $sd[Z]$, $\text{cov}(Z, X)$, and $\text{corr}(Z, Y)$. 'var', '*sd*', 'corr', and 'cov' stand for 'variance', 'standard deviation', 'correlation', and 'covariance' respectively.

9. Suppose *X* is a normally distributed random variable with mean = 1.00 and standard deviation = 2.00.

A. (5 Points): Write down the probability density function of *X*.

B. (5 Points): Take your pencil and make a plot of the probability density function of *X* in a piece of paper. Locate the mean value of *X* in your plot. What is the value of the probability density function at the mean value of *X*?

C. (5 Points): What happens to the probability distribution if the mean of *X* goes up (or goes down) but its standard deviation stays unchanged? What happens to the probability distribution if its standard deviation goes up (or goes down) but its mean stays the same?

D. (5 Points): What is a 'standard normal random variable'?

10. *Y* and *X* are two random variables. Consider the following bivariate regression where a sufficiently large sample of *Y* has been regressed onto the corresponding sample of *X*:

$$y = b_0 + b_1 x + \varepsilon$$

Here b_0, and b_1 are constants (regression coefficients). ε is a random variable representing the error term of the regression. Answer the following questions:

A. (5 Points): What are the assumptions on *Y*, *X*, and ε for the above relation to be a truly valid ordinary least square (OLS) linear regression?

B. (5 Points): Suppose the assumptions of part (A) holds true. What are the formulas to compute b_0, b_1, and $\text{var}[\varepsilon]$ from the sample statistics of *Y* and *X* (that is, from the sample estimates $E[y]$, $E[x]$, $\text{var}[y]$, $\text{var}[x]$, and $\text{cov}(y, x)$)?

C. (5 Points): Suppose $\varepsilon = 0$, that is, the random variables *Y* and *X* are perfectly linearly related in the sample, that is, $y = b_0 + b_1 x$. What are the possible sample correlation coefficients between *Y* and *X*?

D. (5 Points): Suppose it is known that the random variables Y and X are perfectly correlated, that is, corr(Y, X) = ±1. What can you say about the sample regression error ε? What can you say about the sign of the sample regression coefficient b_1?

E. (5 Points): Suppose you found the regression coefficient b_1, and the sample estimates var[y] and var[x]. What formula will you use to compute the R^2 value of the regression from these three estimates? What is the range of possible values of the R^2? How would you interpret high and low values of R^2? Suppose you observe a very low value of R^2, does this mean that the OLS linear regression is invalid?