

**Economics 70, Personal Finance:  
Making Better Decisions and Building a Better Financial System**

**Assignment 5, due on Canvas by 11:59pm on Wednesday October 11**

**1. Measuring the return on a stock**

For this question, you will find it helpful to read pages 495-501 of Kapoor et al.

A stock is selling for \$180 per share. The annual dividend per share is \$4.32 and the earnings per share is \$10.80.

- a) What is the dividend payout ratio?
- b) What is the dividend yield (also known as the dividend-price ratio)?
- c) What is the price-earnings ratio?
- d) You buy 100 shares and a year later you sell them for \$190 per share. What is your total return in dollars?
- e) What fraction of your total return comes from dividends, and what fraction from capital gains?
- f) What is the percentage rate of return on your investment?

**2. The historical return on the US stock market**

Go to <https://dqydj.com/sp-500-return-calculator/> which conveniently calculates the historical average return on the S&P 500 stock index. Choose the earliest possible starting date and choose August 2023 as the ending date. Check the box to adjust for inflation and click the button to calculate. The calculator will give you the “annualized S&P 500 return”, which is just the annualized rate of real capital gains on the S&P index without taking account of dividends. It will also give you the “annualized S&P 500 return (dividends reinvested)”, which is the total real rate of return on the S&P 500 index including dividends.

- a) What is the starting date of your analysis?
- b) What are the two annualized rates of return?
- c) What fraction of the annualized total real return on the S&P 500 index comes from dividends, and what fraction from capital gains?

### 3. Using the normal distribution

Estimates of the average return on stocks vary, but a reasonable estimate (similar to what you found in the previous question) is that a broad stock index such as the S&P 500 will earn 5% per year more than money market funds on average, with a standard deviation of 15%. If each year is independent, then if you invest for 2 years the mean doubles, the variance doubles, and the standard deviation is multiplied by  $\sqrt{2}$ . If you invest for  $N$  years the mean is multiplied by  $N$ , the variance is multiplied by  $N$ , and the standard deviation is multiplied by  $\sqrt{N}$ . Assume that the return is normally distributed no matter how many years you invest for. (Technically this requires that we are working with log returns, but you do not need to worry about this detail here.)

- a) Open the Excel spreadsheet Econ70\_Assignment5\_Question3.xlsx and find the tab Normal Distribution Calculator. Calculate the mean, variance and standard deviation of your return if you invest for the number of years listed under column “Horizons”. Note that your answer should be Excel formulas taking as inputs the contents of cells I2, I3, B3-B14, and (after you have calculated them) the contents of cells D3-14.
- b) We want to know the probability that if you invest in a stock index fund for one year, you will earn a lower return than a money market fund. Cell F3 of the Normal Distribution Calculator shows how to calculate this using an Excel built-in formula. Read the Excel Help explanation for this formula (by double clicking it in the editing mode) and explain
  - i. what this formula does,
  - ii. the meaning of the four arguments that the formula takes,
  - iii. why this formula can answer our question.
- c) Use the same formula and calculate the probabilities for the other years.
- d) Explain intuitively why the probability of losing money in the stock market, relative to the return on a money market fund, changes with the investment horizon.
- e) Use your answers above to explain why Charles Schwab and Vanguard include questions about your investment horizon in their investor questionnaires.

- f) (Bonus question, not required). Now we will run a simulation and see intuitively what happens if we extend the investment horizon.
1. First open the tab Random Returns Generation. The formula given in cell B2 randomly draws a number from the normal distribution with mean 1.05 and standard deviation 0.15. Assume that the money market funds earn unit return each year. Then the number generated by the formula can be interpreted as a one-year return of the S&P500 index.
  2. Assume each year is independent. Use the same formula and generate the returns for year 2-5 in cells C2 – F2. This series of data (B2 – F2) is our first sample. Interpret the numbers.
  3. Repeat step 2 above and generate samples 2 – 100.
  4. You may notice that the spreadsheet generates a new set of numbers every time you edit it. Copy the whole dataset to the tab Simulation. Paste using “Values & Number Formatting” to freeze the numbers.
  5. For each sample, calculate the cumulative returns for 1 year, 2 years, 3 years, 4 years and 5 years.
  6. Cells P2 – P6 calculate the number of years that you earn money automatically. In the simulation, we work with gross returns. So a return greater than 1 means earning money (for example, if you invest \$100 and the annual gross return is 1.05, then at the end of the year you have \$105). Comment on the results. Are the results consistent with what you see in part c)?