Assignment 24: Monte Carlo Simulation

Learning Objectives

• Use random simulation to simulate future stock market returns and investor wealth.
• Quantify the risk of stocks as the chance of losing wealth.

Background

Over the past 80 years, the stock market has an average real (i.e., net of inflation) rate of return of about 9% per year, with a standard deviation of about 20% per year. Due to randomness, we cannot expect to earn 9% real rate of return each year. Some years we'll earn more than 9% and some years we will earn less than 9%.

What is the likely future value of a stock market investment?

Monte Carlo simulation is a quantitative technique used to model systems in which the values are affected by randomness. By running repeated trials, we can make general observations about the range of outcomes we might observe in real life.

Demonstration


2. Generating standard normal distributed random numbers. Use the Excel NORM.S.INV(p) function, where p is the probability from the normal distribution.

3. Generating simulated stock market returns that follow the normal distribution with mean of $\mu = 9\%$, and standard deviation of $\sigma = 20\%$.

$$
return = \mu + Z \cdot \sigma
$$

Use a randomly generated $Z$ value (from demonstrate step 2 above).

Tasks

1. Create rows for years 0-30. Use random number generator to create simulated stock returns for years 1-30 (i.e. top down). Note that the random numbers will recalculate every time to edit the sheet, or when you use CTRL-= (windows) or COMMAND-= (mac).

2. Use simulated returns to calculate the hypothetical change in wealth each year for the 30 years of the simulation. Assume initial wealth at year 0 of 100, and find the wealth in each successive year as:

$$
wealth_n = wealth_{n-1} (1 + r_n)
$$

For example suppose the wealth in year 0 is $100, and the rate of return for year 1 is 10%. The wealth at the end of year 1 is $100 (1 + 0.13) = $113.

3. Run the simulation 10 times. You can either do this by either (a) repeating the work in steps 1 & 2 10 times over, or (b) copying the results and pasting to new cells (do paste special, values so that these do not recalculate after the paste).
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4. Create a line graph illustrating the annual wealth from each of the 10 simulated runs.

5. For comparison, calculate and plot the annual wealth achieved by investing in TIPS. Assume a real rate of return of 3% per year (the historical average real return on long-term Treasury bonds).

Question
Write an explanation for why stocks are risky, even in the long run. Use evidence from your simulation results to support your argument.

What to Submit
Submit your completed workbook and the answers to the questions.