

# Lab Section 03

---

## Exercise 1: Monte Carlo Simulation

Consider the same common stock as in Lab 01 and write down its monthly mean and monthly standard deviation.

Now in Excel, simulate 10 series of 60 months log returns, according to a normal distribution with the mean and standard deviation you wrote down above.

To draw a random number according to a normal distribution with given mean and standard deviation, use the Excel command

`norm.inv(rand(), mean, standard_deviation)`

[Extra: can you explain how and why this formula works?]

For each of the 10 series of 60 months, calculate:

- the sample mean
- the percentage deviation of the sample mean from the true mean
- the sample standard deviation.
- The percentage deviation of the sample standard deviation from the true standard deviation

According to your simulation, which estimate tend to be more precise: the estimate of the mean or the estimate of the standard deviation? Can you guess why?

## Exercise 2: volatility, skewness and kurtosis for cryptocurrencies

Use the monthly data you downloaded from Lab 01 from 2014 onwards: one series for the SP500 returns, one series for the returns on a common stock you like, and one series for the returns on the Bitcoin-to-USD exchange rate (the symbol is BTC-USD on Yahoo finance). Calculate the volatility, skewness and kurtosis. Do the probability distributions of these returns have fat tail? Are large negative returns more likely than large positive returns?

## Exercise 3: stochastic volatility

Go to the website and open the Excel spreadsheet

## Lab 03 Data

The data file contains returns on the S&P500, every day from January 2<sup>nd</sup>, 1926 to December 31<sup>th</sup>, 2021.

### *Skewness and Kurtosis*

Calculate daily returns. Calculate the mean, standard deviation, skewness and kurtosis of the daily returns. According to these measures, does the SP500 returns have fat tails? Are large negative returns more likely than large positive ones?

### *Create a time series of monthly volatilities*

For every day in your sample, except the first 20 trading days:

- Calculate the volatility of the SP500 daily return over the previous 20 trading days. This is a measure of what is called realized volatility.
- Calculate the return over the previous last 20 trading days (which formula from class should you use?)

Now keep the 20-days returns and the realized volatility every 20 days only, and forget about the intermediate data points. (see below for an explanation of how to do this efficiently in Excel)

Now create a scatter plot of the time series of realized volatilities and answer the following questions:

(a) Is volatility approximately constant or does it vary a lot?

(b) When did the 3 biggest spikes of volatility occur? Do you know what happened during these months that caused volatility to spike up so much? To answer this question, a useful website is

<http://www.lexisnexis.com/hottopics/lnacademic/>

which allows you to search major news sources for news stories on specific topics between particular dates.

(c) Create a scatter plot of volatility from 1939 to 1942. Can you relate spikes of volatility to military events (declaration of wars, battles, defeats) of the second world war? What about some of the spikes in other periods?

(d) What is the correlation between the current realized volatility and the realized volatility 20 days earlier? Is it easy to predict the volatility over the next 20 days, based on the volatility in the past 20 days?

(e) What is the correlation between the current return and the return 20 days earlier? Is it easy to predict the mean return over the next 20 days, based on the returns in the past 20 days? Are returns more or less predictable than volatility? What could explain this finding?

(e) What is the correlation between volatility and returns? What does it mean? Is it consistent with your observations about the kind of events that are associated with large volatility spikes?

## An Excel trick

Here is an explanation of how to keep the 20 days returns and realized volatility very 20 days only

1	-0.01
2	0.024
3	0.00002
4	0.1
5	-0.08
...	...
20	0.65
21	0.007

For example: in this table, you would keep only row 1 and row 21, and delete the data in the intermediate rows (2 through 20).

To automate this operation in Excel, check out the following link:

<http://superuser.com/questions/69230/select-each-nth-row-in-excel>