Introduction to Financial Engineering (HW0)

Organizer: Albert Ferreiro-Castilla
room: PC email: `aferreiro@mat.uab.cat`

- Please follow the guidelines for assignments given in the Module Handbook.
- All programs should be written in R (compilable without errors or warnings). Except for question 2 which can be done in Excel or similar Spreadsheet.
- You should submit a write-up (.pdf) of the program as well as the source code (.r). If you use a spreadsheet also submit the third file.
- File names should be as `yoursurname_yourname_HW0.extension`
- You should submit via moddle.
- Deadline: 6th October 2023 at 10am.

The goal of investing is, of course, to make profit. The revenue depends upon both the change in prices and the amounts of asset being held. Investors are interested in revenues that are high relative to the size of the initial investment. Returns measure this because returns on an asset are changes in price expressed as a fraction of the initial price. Returns are scale-free, meaning they do not depend on units.

- **Net Returns**: Let P_t be the price of an asset at time t, the net return is

$$R_t = \frac{P_t}{P_{t-1}} - 1 = \frac{P_t - P_{t-1}}{P_{t-1}} .$$

  Therefore the revenue of an investment is simply the initial investment times the net return.

- **Log Returns**: Called continuously compounded returns are defined as:

$$r_t = \log(1 + R_t) = \log\left(\frac{P_t}{P_{t-1}}\right) = p_t - p_{t-1}$$

  where $p_t = \log(P_t)$ is called the log price.

The following code uses library **quantmod** to download financial datasets, in particular closing prices for Google and S&P composite index.

```
# Stock evolution
# Albert Ferreiro Castilla

rm(list=ls())                              # Removes all variables from workspace
library("quantmod")                        # Library to get prices from Yahoo
options("getSymbols.warning4.0"=FALSE)     # Set off warnings
cat("\f")                                  # Clear console


getSymbols('GOOG',scr='yahoo',from="2011-01-03",to="2014-12-31")
google_close <- GOOG$GOOG.Close

getSymbols('SP',scr='yahoo',from="2011-01-03",to="2014-12-31")
SP_close <- SP$SP.Close
```

1. Consider the daily net returns (from the Close price) of Google (GOOG) stock and the S&P composite index (SP) from January 3, 2011 to December 31, 2014.

   (a) Compute the sample mean, standard deviation, skewness, excess kurtosis, minimum, and maximum of each net return series.

(b) Obtain the empirical density function of the net returns of Google stock. Are the daily net returns normally distributed? Why? Perform a normality test to justify your answer.

(c) Transform the net returns to log returns. Compute the sample mean, standard deviation, skewness, excess kurtosis, minimum, and maximum of each log return series.

(d) Test the null hypothesis that the mean of the log returns of Google stock is zero.

(e) Obtain the empirical density plot of the daily log returns of Google stock and the S&P composite index. Are the daily log returns normally distributed?

(f) Construct a 95% confidence interval for the expected daily log return of Google stock.

2. (This exercise can be done in Excel) OK, so you've found your perfect home, but there's one snag; you're EUR 240.000 short. You therefore need to take out a mortgage from a bank, which is a securitised loan from a bank which you pay off over a period of 30 years. The bank is willing to loan you such a large amount of money because if you fail to pay then the bank takes the property from you to recover its losses. You also pay interest on the mortgage for the duration of the loan, which makes the transaction attractive to the bank. In this particular loan is charging you a 1.99%.

   (a) Compute the monthly installment of the loan.

   (b) Construct a table containing the interest paid and the capital amortization portion of the installment for all payments (360). Summarize it up in a table adding the quantities by year on year.

   (c) How much have you paid back to the bank at the end of the loan.

   (d) Assume that the interest rate applicable is a market index plus a spread. Initially the market index is 1% and the spread (which is kept constant during the life off the loan) is 0.99% (hence the first 12 installments are the same as the previous question). After 1 year the market spread rises 0.10% and continuously does so until the last year, where your market index is 3.90% and your spread is 0.99% (which makes an effective interest rate for the final year of 4.89%). How much have you paid back to the bank at the end of the loan in this new scenario?