## Problem Set I - Reminders

Q1/ Using your own words, explain why if 2 equally risky portfolios  $P_1$  and  $P_2$  are expected to have the same value at the future time T, they must have the same price at all previous times t < T in order to prevent arbitrage opportunity.

Q2/ Assuming you can return 4% every month on your investments. You observed that you can return 4% every month on your investments. How long would it take to turn 100,000 USD into 300,000 USD?

Hint: You will assume here periodic compounding where the interest/profit is reinvested.

Q3/ You are a working in the treasury department of an Icelandic bank. As you manage the liquidity portfolio of the Bank, you are looking for investment opportunities in the bond market. Particularly, your intern comes to you with the term sheet for a new bond, issued by Danske Bank A/S.

Danske Bank - US23636BAQ23	
nominal	1000
issue date	12/6/2018
maturity date	12/6/2028
currency	USD
coupon yield	4.375%
nb payment per year	2
time to maturity	10
coupon amount	21.875
callability	No

On your Bloomberg terminal, you find the term structure of interest rate for the U.S Government bonds (called T-bills), it looks like this:





Your intern modelled this by the following function:

From 0.5Y to 7Y included:

Interest Rate 
$$(t) = 4\% + 0.000352 * (t - 0.5) * 2$$

From 7Y to 40Y included:

Interest Rate 
$$(t) = 4\% + 0.000352 * (7 - 0.5) * 2$$

## a) Price this bond.

Hint: In other word, the interest rate is increasing linearly from 0.5Y to 7Y and is flat after that. Example: if you need to evaluate the interest rate at time t=5 years, the IR is 4%+0.000352\*(5-0.5)\*2 = 4.3168%

- b) Assume now that the interest rate is flat at 5% across all maturities. Reprice this bond
- c) You want to understand more about your bond's sensitivity to interest rate. In other words, you want to know by how much will the value of the bond change, for a change in interest rate of 1 basis point (0.01%). You will calculate the so-called "effective duration", defined by the following formula:

$$Effective\ Duration = \frac{PV_{-} - PV_{+}}{2*PV_{0}*\Delta r}$$

With:

- PV- the new value of the bond when the interest rate moves by 1 basis point down (0.01%),
- PV+ the new value of the bond when the interest rate moves by 1 basis point up (0.01%),
- PV0 the initial value of the bond (from subquestion b))
- $\Delta r$  the change in rate (from PV0 to PV+ or from PV- to PV0).
- **d)** You are working for the Risk department of an Icelandic bank. Notably, you want to measure the risk on the Danske Bank bond we priced on Part III. Under IFRS 9<sup>1</sup>, you are required to measure the impairment (=credit losses) on financial assets using the 'expected credit loss (ECL)' approach. A well-known formula for the Expected Credit Loss (ECL) is provided below:

$$ECL = EAD * PD * LGD$$

With *EAD*, the Exposure at Default, *PD* the default probability and *LGD* the loss given default. The Bank has an exposure of ISK 8 bn on this bond. Based on a consensus of analysts, the default probability of the bond is estimated at 2.3%. It is assumed that in case of default, 60% of the bond's value would be lost. **What is the ECL on the Danske Bank bond?** 

Q4/ For this question, you will be required to code in Python, using the yfinance package (yahoo-finance). Make sure you have it installed:

!pip install yfinance

- a) Fetch 1 year of daily price data for **AAPL**, compute daily log returns, and estimate the **annualized historical volatility** assuming 252 trading days.
- b) Fetch 4 years of historical **daily close prices** for **Microsoft (MSFT)**. Plot i) the stock price ii) the 5-day, 20-day and 40-day moving averages. What can you tell about the lag introduced by a moving average over a longer period? What happened when the 20-day MA is crossing the 40-day MA?
- c) Fetch 2 years of daily price data for the S&P 500 (ticker: ^GSPC).

Compute and plot:

- The cumulative return of investing only overnight (buy at close, sell at next open)
- The cumulative return of investing only intraday (buy at open, sell at close)

Which strategy performs better?

<sup>&</sup>lt;sup>1</sup> A set of accounting standards and rules specifying how an entity should classify and measure financial assets.