

# Portfolio Theory and Risk Management

## Coursework Assignment 2

2.1. Design an *Excel* spreadsheet to implement Markowitz' portfolio optimization technique for portfolios consisting of five different risky assets, taking the expected returns of the assets, the standard deviations of the returns, and the correlations between the returns as input data. The spreadsheet should perform the following tasks:

- (a) Find the weights of the assets in the minimum variance portfolio (MVP) and compute the expected return and standard deviation of the return on the MVP. (20 marks)
- (b) Compute the weights in the portfolio with the smallest standard deviation for any given value of the expected return on the portfolio; also compute the standard deviation of this portfolio. (20 marks)
- (c) Plot the minimum variance line (line of portfolios with smallest variance at a given expected return level) on the  $\sigma, \mu$  plane, along with the points representing MVP and assets. (10 marks)

2.2. (a) Given a risk level  $\sigma$ , derive a formula for a portfolio  $w(\sigma)$ , for which

$$E(K_{w(\sigma)}) = \max\{E(K_w) | w^T \mathbf{1} = 1, w^T C w = \sigma^2\}.$$

Present a detailed derivation of the formula in the lyx and pdf files. (30 marks)

- (b) In Excel, for a given  $\sigma$  compute  $w(\sigma)$  and  $E(K_{w(\sigma)})$ . Add the point  $(\sigma, E(K_{w(\sigma)}))$  to the plot in the spreadsheet. <sup>1</sup> (10 marks)
- (c) In Excel, for a given sequence  $\sigma_1, \sigma_2, \dots, \sigma_n$  give a table

$\sigma$	$\mu$
$\sigma_1$	$E(K_{w(\sigma_1)})$
$\sigma_2$	$E(K_{w(\sigma_2)})$
$\vdots$	$\vdots$
$\sigma_n$	$E(K_{w(\sigma_n)})$

Based on the table produce a plot of the set of efficient portfolios (portfolios that are not dominated by any other portfolios than themselves) on the  $\sigma, \mu$  plane. (10 marks)

The completed assignment should consist of:

<sup>1</sup>This can be solved either by using the formula derived in 2.2 (a) or by some other method, provided that the end user can enter a  $\sigma$  of his choice, and based on it  $w(\sigma)$  and  $E(K_{w(\sigma)})$  are computed by the spreadsheet.

- *Excel* spreadsheet files of type .xls;
- A single file containing the solution of 2.2 (a) and notes explaining the computations in the Excel solution. This file is to be submitted in both .lyx and .pdf format;

Marks in this assignment will be given for content, accuracy, software design, software documentation, ease of use and presentation style.