SEMINAR 2: **PRICING OF RISKY ASSETS**

FINANCIAL ECONOMICS

May 17, 2022

1. June Exam 2010/11

Consider an economy with a risk-free bond (asset 0) and two risky shares (assets 1 and 2). The return of the risk-free asset (the interest rate) is r = 5%. The properties of the returns of the risky assets (in %) are resumed in the next table:

	$\mathbb{E}[R_i]$	σ_i
Asset 1	6,08	4,81
Asset 2	15,88	23,32

Correlation between these returns: $Corr(R_1, R_1,) = \rho_{12} = 0$.

We assume that CAPM holds. The market portfolio invests 70% in asset 1 and 30% in asset 2.

1. June Exam 2010/11$\rightarrow$ (a)

(a)
(i) Compute the expected return and volatility of the market portfolio.
(ii) Compute the betas of the 3 assets.

The market portfolio is built by investing $\omega_1 = 70\%$ in asset 1 and $\omega_2 = 30\%$ in asset 2.

(i) The expected return and volatility of the market portfolio are given by

$$\mathbb{E}\left[R_M\right] = \omega_1 \mathbb{E}\left[R_1\right] + \omega_2 \mathbb{E}\left[R_2\right] = 0,7 * 6,08\% + 0,3 * 15,88\% = 9,02\%$$

$$\sigma_M = \sqrt{(\omega_1 \sigma_1)^2 + (\omega_2 \sigma_2)^2} = \sqrt{(0,7 * 4,81\%)^2 + (0,3 * 23,32\%)^2} = 7,76\%$$

(ii) The beta of asset i is given by

$$\beta_i = \frac{Cov(R_i, R_M)}{\sigma_M^2}$$

1. June Exam 2010/11$\rightarrow$ (a)

Asset 0 (safe asset)

$$Cov(R_0, R_M) = 0 \implies \boxed{\beta_0 = 0}$$

Asset 1

$$Cov(R_1, R_M) = Cov(R_1, \underbrace{\omega_1 R_1 + \omega_2 R_2}_{=R_M}) = \omega_1 \underbrace{Cov(R_1, R_1)}_{=\sigma_1^2} + \omega_2 \underbrace{Cov(R_1, R_2)}_{=0} = \omega_1 \sigma_1^2$$

$$\beta_1 = \frac{\omega_1 \sigma_1^2}{\sigma_M^2} = \frac{0,7 * (4,81^2)}{(7,76)^2} = 0,27 \implies \boxed{\beta_1 = 0,27}$$

Assets 2

$$Cov(R_2, R_M) = Cov(R_2, \underbrace{\omega_1 R_1 + \omega_2 R_2}_{=R_M}) = \omega_1 \underbrace{Cov(R_2, R_1)}_{=0} + \omega_2 \underbrace{Cov(R_2, R_2)}_{=\sigma_2^2} = \omega_2 \sigma_2^2$$

$$\beta_2 = \frac{\omega_2 \sigma_2^2}{\sigma_M^2} = \frac{0,3 * (23,32^2)}{(7,76)^2} = 2,71 \implies \boxed{\beta_2 = 2,71}$$

1. June Exam 2010/11 $\rightarrow$ (b) (i)

(b) (i) Represent the Capital Market Line (CML) and the three assets in the mean-standard deviation space.

Capital Market Line (CML) represents the relationship between expected return and risk of efficient portfolios. Efficient portfolio p satisfies:

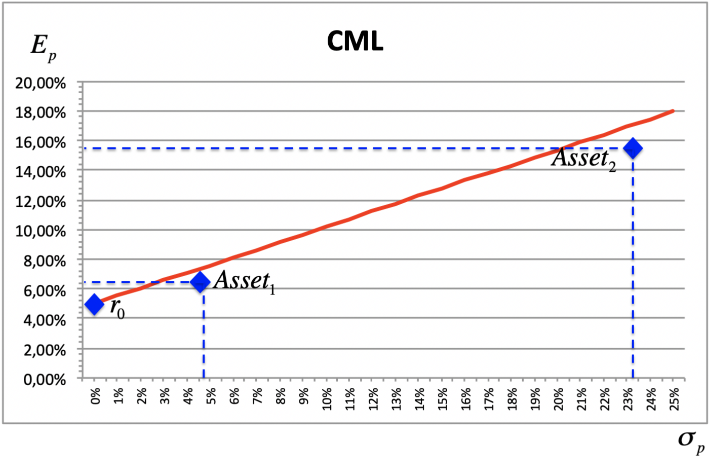
$$\mathbb{E}\left[R_p\right] = R_0 + \underbrace{\left[\frac{\mathbb{E}\left[R_M\right] - R_0}{\sigma_M}\right]}_{\text{Sharpe ratio}} \sigma_P$$

Plugging the values provided

$$\mathbb{E}\left[R_p\right] = 5\% + \underbrace{\left[\frac{9,02\% - 5\%}{7,76\%}\right]}_{=\,0{,}52} \sigma_P \implies \boxed{\mathbb{E}\left[R_p\right] = 5\% + 0,52 * \sigma_P}$$

1. June Exam 2010/11 → (b) (i)

Asset 1 and asset 2 are below the CML



1. June Exam 2010/11 $\rightarrow$ (b) (ii)

(b) (ii) Represent in another graph the Security Market Line (SML) and the three assets.

The security Market line (SML) represents the relationship between expected returns and betas.

The SML says that any asset i satisfies:

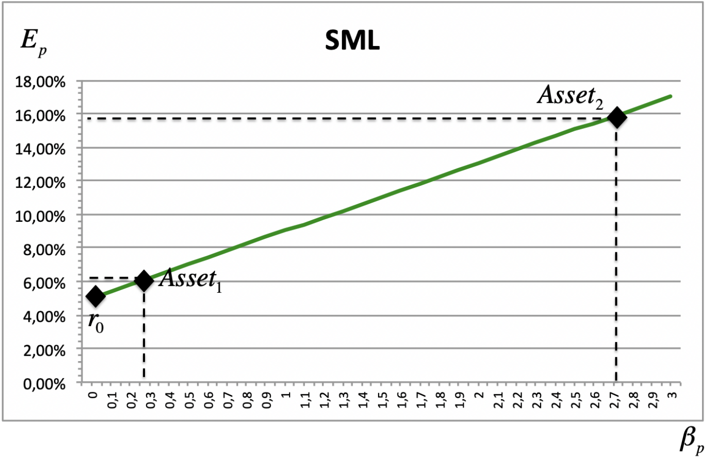
$$\mathbb{E}[R_i] = R_0 + \beta_i \left[\mathbb{E}[R_M] - R_0\right]$$

Plugging the values provided

$$\mathbb{E}[R_i] = 5\% + \beta_i [9,02\% - 5\%] \implies \boxed{\mathbb{E}[R_i] = 5\% + 4,02\% \beta_i}$$

1. June Exam 2010/11 → (b) (ii)

Given that CAMP holds, all assets have to be on the SML



1. June Exam 2010/11 → (c)

(c) Compute the efficient portfolio with an expected return of 12%, its volatility, its beta and the fraction of the total wealth of the investor in each of the 3 assets.

An efficient portfolio P_c with expected return 12% is given by

$$\mathbb{E}\left[R_{P_c}\right] = (1 - \omega_M)R_0 + \omega_M \mathbb{E}\left[R_M\right] = 12\%$$

$$\Longrightarrow \ \omega_M = \frac{12\% - R_0}{\mathbb{E}\left[R_M\right] - R_0} = \frac{12\% - 5\%}{9,02\% - 5\%} = 1,74$$

The volatility of portfolio P_c

$$\sigma_{P_c} = \omega_M \sigma_M = 1,74 * 7,76\% = 13,5\%$$

1. June Exam 2010/11 $\rightarrow$ (c)

(c) Compute the efficient portfolio with an expected return of 12%, its volatility, its beta and the fraction of the total wealth of the investor in each of the 3 assets.

The beta of the portfolio P_c is given by

$$\beta_{P_c} = \frac{Cov(R_{P_c}, R_M)}{\sigma_M^2}$$

The numerator is given by

$$Cov(R_{P_c}, R_M) = Cov(\underbrace{\omega_0 R_0 + \omega_M R_M}_{=R_{P_c}}, R_M) = \omega_0 \underbrace{Cov(R_0, R_M)}_{=0} + \omega_M \underbrace{Cov(R_M, R_M)}_{=\sigma_M^2}$$

$$Cov(R_{P_c}, R_M) = \omega_M \sigma_M^2 \implies \boxed{\beta_{P_c} = \omega_M = 1,74}$$

The weights in each asset of portfolio P_c $\rightarrow$ $\begin{cases} \omega_0 = 1 - 1,74 = -0,74 \\ \omega_1' = 1,74 * 0,7 = 1,22 \\ \omega_2' = 1,74 * 0,3 = 0,52 \end{cases}$

1. June Exam 2010/11$\rightarrow$ (d)

(d) Compute the efficient portfolio with volatility of 5%, its expected return , its beta and the fraction of the total wealth of the investor in each of the 3 assets.

An efficient portfolio P_d with volatility 5% is given by

$$\sigma_{P_d} = \omega_M \sigma_M = 5\% \implies \omega_M = \frac{5\%}{\sigma_M} = \frac{5\%}{7,76\%} = 0,64$$

The expected return of Portfolio P_d is given by

$$\mathbb{E}\left[R_{P_d}\right] = (1 - \omega_M) R_0 + \omega_M \mathbb{E}\left[R_M\right]$$
$$\mathbb{E}\left[R_{P_d}\right] = 0,36 * 5\% + 0,64 * 9,02\% = 7,59\%$$

1. June Exam 2010/11 $\rightarrow$ (d)

(d) Compute the efficient portfolio with volatility of 5%, its expected return , its beta and the fraction of the total wealth of the investor in each of the 3 assets.

Following the same steps as before, the beta of the portfolio P_d is given by

$$\beta_{P_d} = \omega_M = 0,64$$

The weights in each asset of portfolio $P_d \rightarrow$ $\begin{cases} \omega_0 = 1 - 0,64 = 0,36 \\ \omega_1' = 0,64 * 0,7 = 0,45 \\ \omega_2' = 0,64 * 0,3 = 0,19 \end{cases}$

1. June Exam 2010/11$\rightarrow$ (e)

(e) Compute the efficient portfolio with beta 0.5, its volatility, its expected return , its beta and the fraction of the total wealth of the investor in each of the 3 assets.

We know form the previous section that an efficient portfolio P_e with beta 0.5

$$\beta_{P_e} = 0,5 \implies \omega_M = 0,5$$

Then the expected return an volatility of portfolio P_e

$$\mathbb{E}\left[R_{P_e}\right] = 0,5 * 5\% + 0,5 * 9,02\% = 7,01\%$$
$$\sigma_{P_e} = \omega_M \sigma_M = 0,5 * 7,76\% = 3,88\%$$

The weights in each asset of portfolio $P_e \rightarrow \begin{cases} \omega_0 = 1 - 0,5 = 0,5 \\ \omega_1' = 0,5 * 0,7 = 0,35 \\ \omega_2' = 0,5 * 0,3 = 0,15 \end{cases}$

2. June Exam 2011/12

Consider an economy with two dates (1 period) and two risky assets, A and B. Asset A has a rate of return whose expected value is 25% and whose volatility (standard deviation) is 20%, while asset B has a rate of return whose expected value is 10% and whose volatility is 10%. The correlation between the returns of assets A and B is 0.

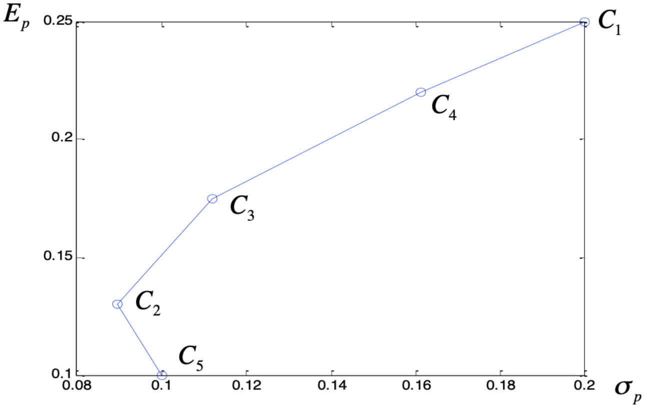
a) Calculate the expected return and volatility of the portfolios described in the table below (portfolios C1 to C5). Plot the 5 portfolios in the mean-standard deviation space. One of these portfolios is the minimum variance portfolio: knowing this, determine which portfolios belong to the efficient frontier.

Portfolio	C1	C2	C3	C4	C5
% weight of asset A	100%	20%	50%	80%	0%

2. June Exam 2011/12→ (a)

Portfolio	C1	C4	C3	C2	C5
weight A	**100%**	**80%**	**50%**	**20%**	0%
E portfolio	**25,00%**	**22,00%**	**17,50%**	**13,00%**	10,00%
Vol portfolio	**20,00%**	**16,12%**	**11,18%**	**8,94%**	10,00%

The minimum variance portfolio is C2 → C1, C2, C3 and C4 are efficient portfolios



2. June Exam 2011/12 $\rightarrow$ (b)

b) Suppose that a third asset is introduced into this economy, which has no risk and offers a return of r=5%. Knowing that one of the 5 portfolios above is the tangent portfolio, say which one it is and why. Assuming that all the conditions for the CAPM to hold are met, write the equation of the Capital Market Line (CML) in this economy and plot it in a graph.

The Sharpe ratio of portfolio P is given by (where R_0 is the return of the safe assets)

$$S_P = \frac{\mathbb{E}\left[R_P\right] - R_0}{\sigma_P}$$

Then, the Shape ratio of each portfolio

$$\begin{aligned}
&\textbf{Portfolio C1} \rightarrow S_{C1} = 1 \\
&\textbf{Portfolio C4} \rightarrow S_{C4} = 1,05 \\
&\textbf{Portfolio C3} \rightarrow S_{C3} = 1,12 \\
&\textbf{Portfolio C2} \rightarrow S_{C2} = 0,89 \\
&\textbf{Portfolio C5} \rightarrow S_{C5} = 0,5
\end{aligned}$$

Given that the tangent portfolio has the highest Sharpe ratio $\rightarrow$ the tangent portfolio is C3 ($S_{C3} = 1,12$)

2. June Exam 2011/12$\rightarrow$ (b)

b) Suppose that a third asset is introduced into this economy, which has no risk and offers a return of r=5%. Knowing that one of the 5 portfolios above is the tangent portfolio, say which one it is and why. Assuming that all the conditions for the CAPM to hold are met, write the equation of the Capital Market Line (CML) in this economy and plot it in a graph.

The Capital Market Line (CML) in this economy is given by

$$\mathbb{E}\left[R_P\right] = R_0 + \left[\frac{\mathbb{E}\left[R_T\right] - R_0}{\sigma_T}\right]\sigma_p$$

Given that the tangent portfolio is C3 and its Sharpe ratio $S_{C3} = 1,12$

$$\boxed{\mathbb{E}\left[R_P\right] = 5\% + 1,12\sigma_p}$$

2. June Exam 2011/12$\rightarrow$ (c)

c) Given your answers to previous questions, if you are willing to hold a portfolio with a volatility of 15%, what is the maximum expected return that you could achieve in this market? Specify the fraction of total wealth invested in each of the three assets. (Hint: first determine the fraction of total wealth you must invest in the tangent (market) portfolio and the riskless asset, then, given this, the fraction of total wealth in assets A and B).

The maximum expected return of a portfolio P with volatility of 15% is given

$$\text{CML} \ \rightarrow \mathbb{E}\left[R_P\right] = 5\% + 1,12 * 15\% = 21,8\%$$

In order to find the weight in the tangent (market) portfolio (C3)

$$\sigma_p = \omega_M \sigma_M = 15\% \implies \omega_M = \frac{15\%}{11,18\%} = 1,34$$

The weights in each asset of portfolio $P \rightarrow$ $\begin{cases} \omega_0 = 1 - 1,34 = -0,34 \\ \omega_A' = 1,34 * 0,5 = 0,67 \\ \omega_B' = 1,34 * 0,5 = 0,67 \end{cases}$

2. June Exam 2011/12→ (d)

d) Assuming that the CAPM holds, calculate the betas of assets A and B with respect to the market portfolio and check that both assets are on the Securities Market Line (SML).

$$\text{SML} \;\rightarrow \mathbb{E}\left[R_i\right] = R_0 + \beta_i\left[\mathbb{E}\left[R_M\right] - R_0\right] \implies \mathbb{E}\left[R_i\right] = 5\% + \beta_i 12,5\%$$

where $\beta_i = \frac{Cov(R_i, R_M)}{\sigma_M^2}$

The beta of asset A

$$Cov(R_A, R_M) = \omega_A \sigma_A^2 \implies \beta_A = \frac{\omega_A \sigma_A^2}{\sigma_M^2} = \frac{0,5 * 20^2}{11,18^2} = 1,6$$

$$\text{SML} \;\rightarrow \mathbb{E}\left[R_A\right] = 5\% + 1,6 * 12,5\% = 25\%$$

The beta of asset B

$$Cov(R_B, R_M) = \omega_B \sigma_B^2 \implies \beta_B = \frac{\omega_B \sigma_B^2}{\sigma_M^2} = \frac{0,5 * 10^2}{11,18^2} = 0,4$$

$$\text{SML} \;\rightarrow \mathbb{E}\left[R_B\right] = 5\% + 0,4 * 12,5\% = 10\%$$

2. June Exam 2011/12 $\rightarrow$ (e)

(e) How would you combine the risk-free asset with the market portfolio so that the resulting portfolio beta was 0.7?

$$\beta_P = \frac{Cov(R_P, R_M)}{\sigma_M^2}$$

where the numerator is given by

$$Cov(R_P, R_M) = Cov(\omega_0 R_0 + \omega_M R_M, R_M) = \omega_M \sigma_M^2 \implies \beta_P = \omega_M$$

Then, an investor should invest a fraction $\omega_M = 0,7$ of her wealth in the market portfolio and a fraction $\omega_0 = 0,3$ of her wealth in the risk-free asset.

3. June 2016

Suppose that there exists an economy with one period (two dates, t=0 and t=1). In this economy there are a risk-free asset and 2 risky assets (A and B). The risk-free asset offers an interest rate of 4%. Asset A has an expected return of 20% with volatility (standard deviation) of 40%. Asset B has an expected return of 10% and volatility of 30%. The correlation between returns of assets A and B is 0.

3. June 2016

The market portfolio consists of 60% of asset A and 40% of asset B. Calculate the expected return, volatility, and Sharpe ratio of the market portfolio.

The expected return of the market portfolio is given by

$$\mathbb{E}\left[R_M\right] = \omega_A \mathbb{E}\left[R_A\right] + \omega_B \mathbb{E}\left[R_B\right] = 0,6 * 20\% + 0,4 * 10\% = 16\%$$

The volatility of the market portfolio is given by

$$\sigma_M = \sqrt{(\omega_A \sigma_A)^2 + (\omega_B \sigma_B)^2} = \sqrt{(0,6 * 40\%)^2 + (0,4 * 30\%)^2} = 26,83\%$$

The Sharpe ratio (where R_0 is the return of the risk-free asset)

$$S_M = \frac{\mathbb{E}\left[R_M\right] - R_0}{\sigma_M} = \frac{16\% - 4\%}{26,83\%} = 0,45$$

3. June 2016

Calculate the portfolio weights in each of the three assets for an investor who wants to maximize her expected return, while assuming a volatility of 30%?

A portfolio P that maximizes the expected return given a volatility of 30%, is constructed by investing ω_0 in the safe asset and ω_M in the market portfolio such that

$$\sigma_P = \omega_M \sigma_M = 30\% \implies \omega_M = \frac{30\%}{\sigma_M} = \frac{30\%}{26,83\%} = 1,12$$

Hence, the weights of portfolio P in each asset are given by

$$\begin{cases} \omega_0 = 1 - 1,12 = -0,12 \\ \omega_A' = 1,12 * 0,60 = 0,67 \\ \omega_B' = 1,12 * 0,4 = 0,45 \end{cases}$$

3. June 2016

What would be the beta of the investor's portfolio in the previous question?

The beta of portfolio P is given by

$$\beta_P = \frac{Cov(R_P, R_M)}{\sigma_M^2}$$

where the numerator is given by

$$Cov(R_P, R_M) = Cov(\omega_0 R_0 + \omega_M R_M, R_M) = \omega_0 \underbrace{Cov(R_0, R_M)}_{=0} + \omega_M \underbrace{Cov(R_M, R_M)}_{=\sigma_M^2}$$

$$Cov(R_P, R_M) = \omega_M \sigma_M^2 \implies \boxed{\beta_P = \omega_M = 1,12}$$

3. June 2016

Calculate the betas of assets A and B and verify that the CAPM holds in this economy.

The beta of asset A is given by

$$Cov(R_A, R_M) = Cov(R_A, \underbrace{\omega_A R_A + \omega_B R_B}_{R_M})$$

$$Cov(R_A, R_M) = \omega_A \underbrace{Cov(R_A, R_A)}_{=\sigma_A^2} + \omega_B \underbrace{Cov(R_A, R_B)}_{=0(\rho=0)} = \omega_A \sigma_A^2$$

$$\beta_A = \frac{Cov(R_A, R_M)}{\sigma_M^2} = \frac{\omega_A \sigma_A^2}{\sigma_M^2} = \frac{0,6 * (40\%)^2}{(26,83\%)^2} = 1,33$$

Following the same steps, the beta of asset B is given by

$$\beta_B = \frac{\omega_B \sigma_B^2}{\sigma_M^2} = \frac{0,4 * (30\%)^2}{(26,83\%)^2} = 0,50$$

3. June 2016

Calculate the betas of assets A and B and verify that the CAPM holds in this economy.

In order to verified that the CAPM holds,

$$\mathbb{E}[R_i] = R_0 + \beta_i [\mathbb{E}[R_M] - R_0]$$
$$\mathbb{E}[R_i] = 4\% + \beta_i 12\%$$

Asset A

$$\mathbb{E}[R_A] = 4\% + \beta_A 12\% = 4\% + 1,33 * 12\% = 20\%$$

Asset B

$$\mathbb{E}[R_B] = 4\% + \beta_B 12\% = 4\% + 0,5 * 12\% = 10\%$$

Hence, CAMP holds.

4. June 2017

Questions 8-10: Let us suppose an economy with one period and two dates (t=0 y t=1). In this economy, there is a risk-free asset (bond) and 2 risky assets, A and B. The bond offers a 2% interest rate. Asset A has an expected rate of return (or yield) of 10% and a volatility (standard deviation) of 20%. Asset B has a return of 20% and a volatility of 40%. The correlation between both returns is 0. We will assume that the CAPM conditions hold.

(a) Knowing that the market portfolio has weight of 64% in Asset A and 36% in Asset B, calculate the Sharpe ratio for the Market portfolio.

(b) What positions must an investor take if she wishes to obtain an expected return of 15% with the lowest possible volatility?

(c) Calculate the betas of A and B:

4. June 2017

Questions 8-10: Let us suppose an economy with one period and two dates (t=0 y t=1). In this economy, there is a risk-free asset (bond) and 2 risky assets, A and B. The bond offers a 2% interest rate. Asset A has an expected rate of return (or yield) of 10% and a volatility (standard deviation) of 20%. Asset B has a return of 20% and a volatility of 40%. The correlation between both returns is 0. We will assume that the CAPM conditions hold.

(a) **Knowing that the market portfolio has weight of 64% in Asset A and 36% in Asset B, calculate the Sharpe ratio for the Market portfolio.**

(b) What positions must an investor take if she wishes to obtain an expected return of 15% with the lowest possible volatility?

(c) Calculate the betas of A and B:

4. June 2017$\rightarrow$ (a)

The market portfolio has weight of $\omega_A = 0,64$ in asset A and $\omega_B = 0,36$ in asset B. The expected return of the market portfolio is given by

$$\mathbb{E}\left[R_M\right] = \omega_A \mathbb{E}\left[R_A\right] + \omega_B \mathbb{E}\left[R_B\right] = 0,64 * 10\% + 0,36 * 20\% = 13,6\%$$

The volatility of the market portfolio is given by

$$\sigma_M = \sqrt{(\omega_A \sigma_A)^2 + (\omega_B \sigma_B)^2} = \sqrt{(0,64 * 20\%)^2 + (0,36 * 40\%)^2} = 19,27\%$$

The Sharpe ratio of the market portfolio is given by (where R_0 is the return of the safe asset)

$$S_M = \frac{\mathbb{E}\left[R_M\right] - R_0}{\sigma_M} = \frac{13,6\% - 2\%}{19,27\%} = 0,6021$$

4. June 2017

Questions 8-10: Let us suppose an economy with one period and two dates (t=0 y t=1). In this economy, there is a risk-free asset (bond) and 2 risky assets, A and B. The bond offers a 2% interest rate. Asset A has an expected rate of return (or yield) of 10% and a volatility (standard deviation) of 20%. Asset B has a return of 20% and a volatility of 40%. The correlation between both returns is 0. We will assume that the CAPM conditions hold.

(a) Knowing that the market portfolio has weight of 64% in Asset A and 36% in Asset B, calculate the Sharpe ratio for the Market portfolio.

(b) **What positions must an investor take if she wishes to obtain an expected return of 15% with the lowest possible volatility?**

(c) Calculate the betas of A and B:

4. June 2017 → (b)

If an investor want to obtain an expected return of 15% with the lowest possible volatility, then

$$\text{CML} \;\rightarrow \mathbb{E}\left[R_P\right] = R_0 + S_M \sigma_P = 2\% + 0,6021 \sigma_P = 15\%$$

$$\sigma_P = \frac{15\% - 2\%}{0,6021} = 21,59\%$$

And given that

$$\sigma_P = \omega_M \sigma_M \implies \omega_M = \frac{\sigma_P}{\sigma_M} = \frac{21,59\%}{19,27\%} = 1,12$$

Hence, the weights in each asset of the market portfolio are given by

$$\begin{cases} \omega_0 = 1 - 1,12 = -0,12 \\ \omega_A' = 1,12 * 0,64 = 0,72 \\ \omega_B' = 1,12 * 0,36 = 0,4 \end{cases}$$

4. June 2017

Questions 8-10: Let us suppose an economy with one period and two dates (t=0 y t=1). In this economy, there is a risk-free asset (bond) and 2 risky assets, A and B. The bond offers a 2% interest rate. Asset A has an expected rate of return (or yield) of 10% and a volatility (standard deviation) of 20%. Asset B has a return of 20% and a volatility of 40%. The correlation between both returns is 0. We will assume that the CAPM conditions hold.

(a) Knowing that the market portfolio has weight of 64% in Asset A and 36% in Asset B, calculate the Sharpe ratio for the Market portfolio.

(b) What positions must an investor take if she wishes to obtain an expected return of 15% with the lowest possible volatility?

(c) **Calculate the betas of A and B**

4. June 2017 $\rightarrow$ (c)

The beta of asset i is given by

$$\beta_i = \frac{Cov(R_i, R_M)}{\sigma_M^2}$$

Asset A

$$Cov(R_A, R_M) = Cov(R_A, \omega_A R_A + \omega_B R_B) = \omega_A \underbrace{Cov(R_A, R_A)}_{=\sigma_A^2} + \omega_B \underbrace{Cov(R_A, R_B)}_{=0(\rho=0)}$$

$$Cov(R_A, R_M) = \omega_A \sigma_A^2 \implies \beta_A = \frac{\omega_A \sigma_A^2}{\sigma_M^2} = \frac{0,64 * (20\%)^2}{(19,27\%)^2} = 0,69$$

Asset B

$$Cov(R_B, R_M) = Cov(R_B, \omega_A R_A + \omega_B R_B) = \omega_A \underbrace{Cov(R_B, R_A)}_{=0(\rho=0)} + \omega_B \underbrace{Cov(R_B, R_B)}_{=\sigma_B^2}$$

$$Cov(R_B, R_M) = \omega_B \sigma_B^2 \implies \beta_B = \frac{\omega_B \sigma_B^2}{\sigma_M^2} = \frac{0,36 * (40\%)^2}{(19,27\%)^2} = 1,55$$