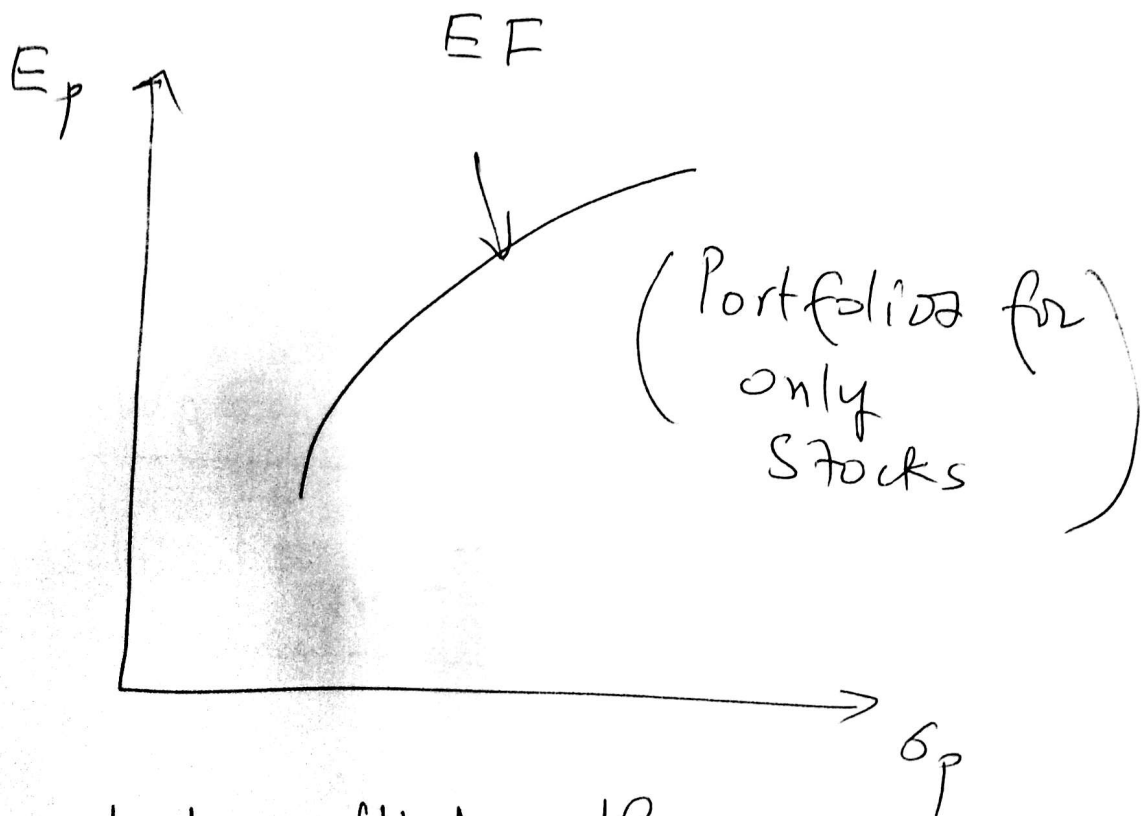


Capital Market Line (CML)

let's consider a PF. Combining 1 Stock and 1 Bond.



What will be the new Efficient Frontier if we include RFR (T-Bills)?

Let's consider a PF of 1 Stock (Stock A) and 1 Bond (T-Bill with RFR).

With weights w_A and w_{RFR} ($w_A + w_{RFR} = 1$).

$$E(R_P) = w_A E_A + w_{RFR} \cdot RFR \quad (1)$$

$$w_A + w_{RFR} = 1 \Rightarrow w_{RFR} = 1 - w_A$$

$$E(R_P) = w_A E_A + (1 - w_A) \cdot RFR$$

$$\rightarrow E(R_P) = w_A [E_A - RFR] + RFR \quad \underline{\underline{\text{Eq. 1.}}}$$

$$\sigma_P^2 = w_A^2 \sigma_A^2 + w_{RFR}^2 \sigma_{RFR}^2 + 2w_A w_{RFR} \text{COV}(A, RFR)$$

$$\sigma_P^2 = w_A^2 \sigma_A^2 \Rightarrow \sigma_P = w_A \sigma_A \quad \underline{\underline{\text{Eq. 2}}}$$

$$\Rightarrow w_A = \frac{\sigma_P}{\sigma_A}$$

$$\underline{\underline{\text{Eq. 1}}} : E(R_P) = \frac{\sigma_P}{\sigma_A} [E_A - RFR] + RFR$$

(2)

$y = a + b x$
Comments:-

1. Linear relationship between Expected Return E_p and Total Risk (σ_p) for all the Efficient Portfolios combining Stocks and Bonds.

$$2. \left(\frac{E_A - RFR}{\sigma_A} \right) > 0, E_A > RFR$$

E_p is a positively linked to σ_p .

3. $\left(\frac{E_A - RFR}{\sigma_A} \right)$: Is the Risk Price
= the Risk Premium per each unit of risk (Total Risk).

$$4. E_p = RFR + \left[\frac{E_A - RFR}{\sigma_A} \right] \cdot \sigma_p$$

is called the Capital Market Line (CML)

(3)

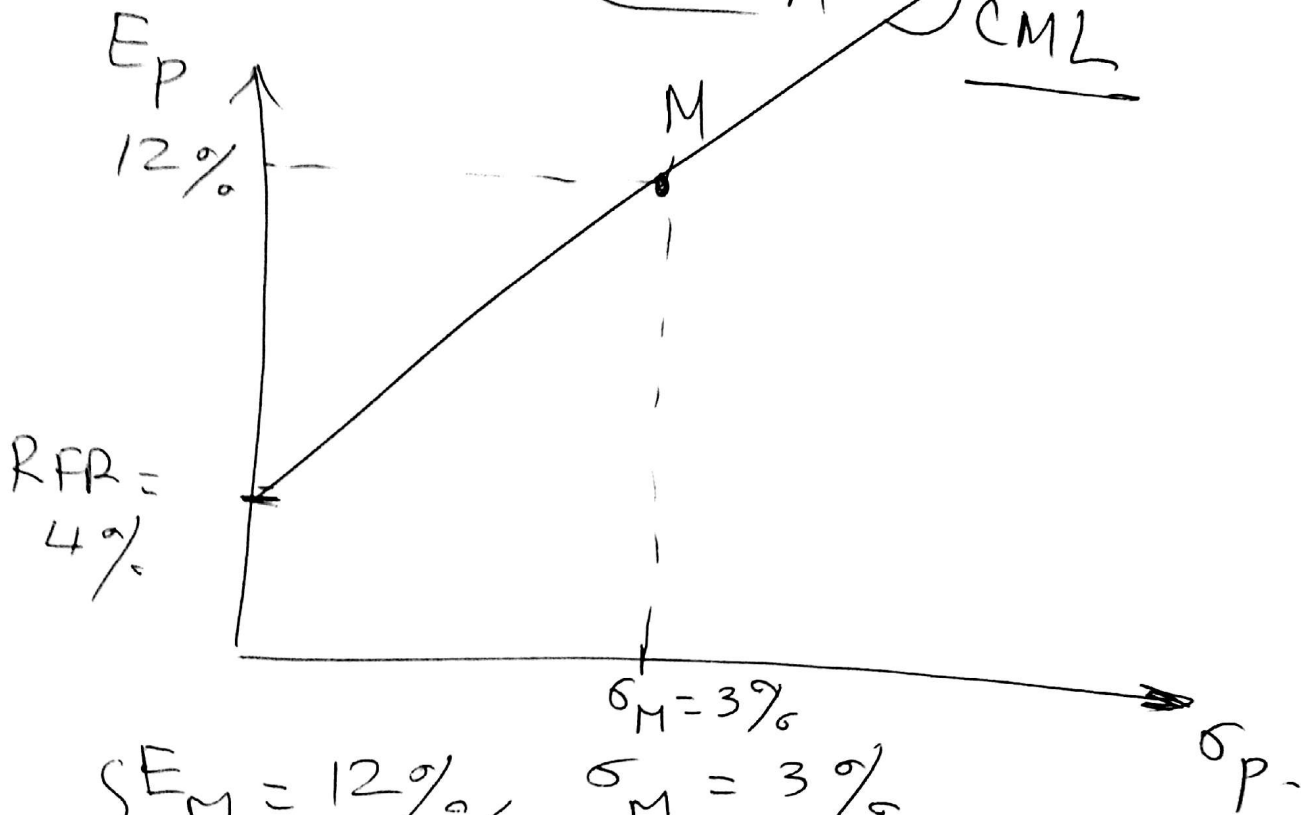
$$\text{SML: } E_p = RFR + \left[E_M - RFR \right] \beta_i$$

$$\text{CML: } E_p = RFR + \left[\frac{E_M - RFR}{\sigma_M} \right] \cdot \sigma_p$$

Market
Market
Single Index
Model

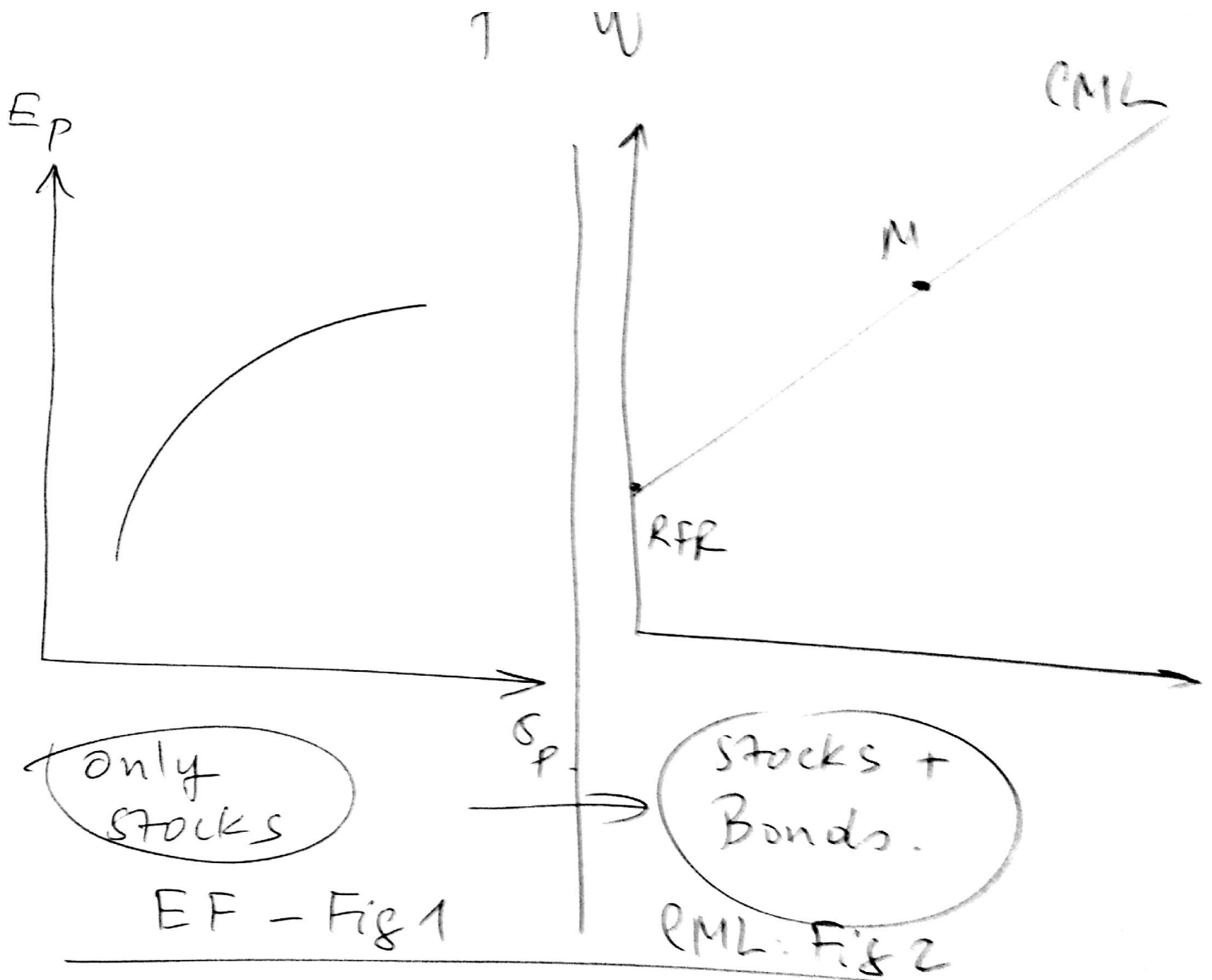
$$\Rightarrow \hat{R}_i = \alpha_i + \beta_i \hat{R}_M + \epsilon_{it}$$

$$E_p = RFR + \left[\frac{E_M - RFR}{\sigma_M} \right] \cdot \sigma_p \quad \text{CML}$$

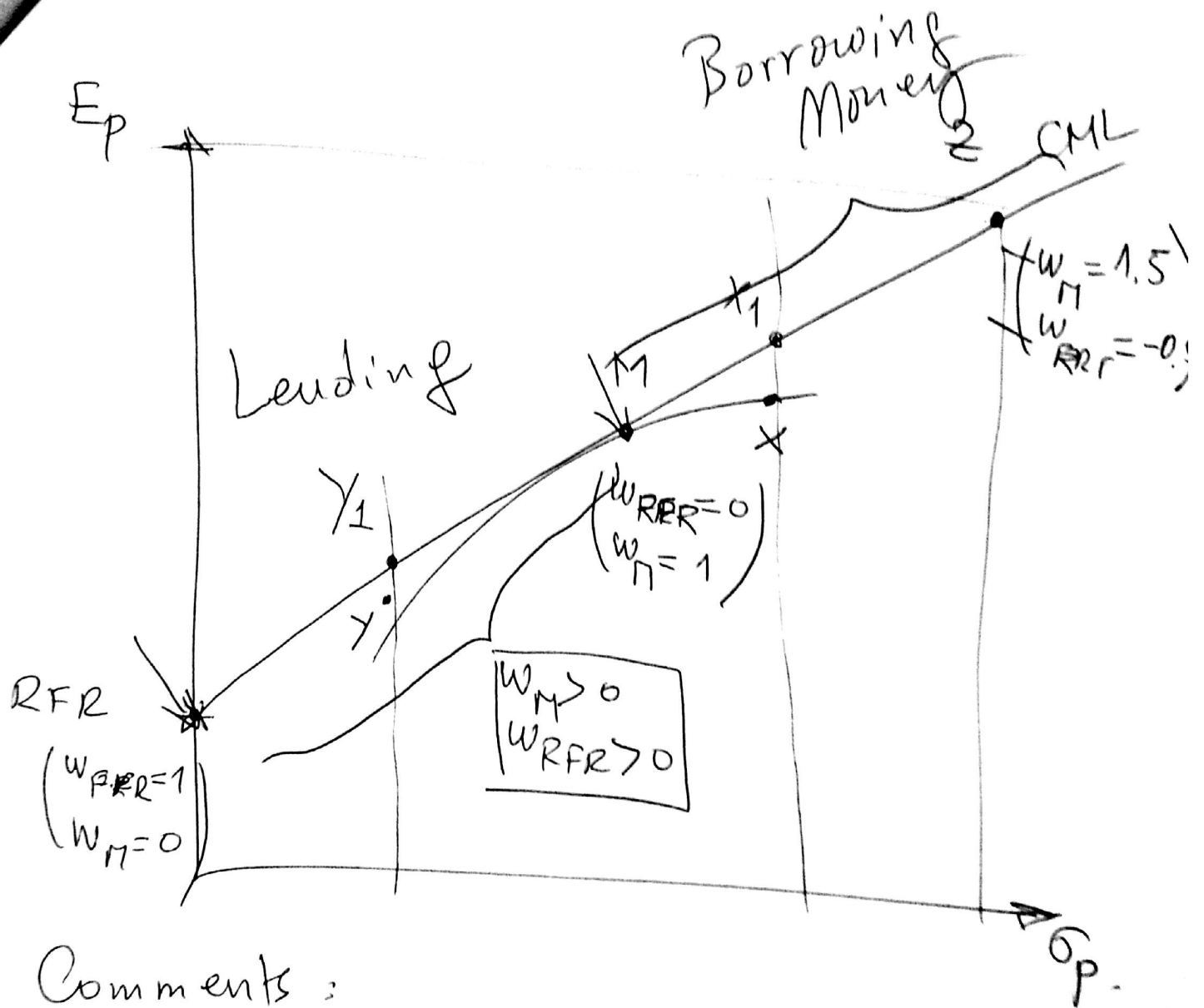


$\left\{ \begin{array}{l} E_M = 12\%, \quad \sigma_M = 3\% \\ RFR = 4\% \end{array} \right.$, Plot the CML

(E)



6



Comments :

1. z is a possible and efficient because it is located on the CML.
 2. z is constructed using leverage effect: It means that:
 - f Long position on Stocks (1.5)
 - f Short on Bonds (-0.5) \Rightarrow
 - Borrowing Money.
- (7)

3. Investors Borrow money at the RFR to invest more in the Market portfolio; so, they are using leverage effect to beat the Market \Rightarrow
- Higher Expected Return than the Market.
 - $E_Z > E_M$ and $\sigma_Z > \sigma_M$.
- 4.

[RFR, M]: We are lending

- Long on Stocks
- Long on Bonds

(M, Z) We are Borrowing

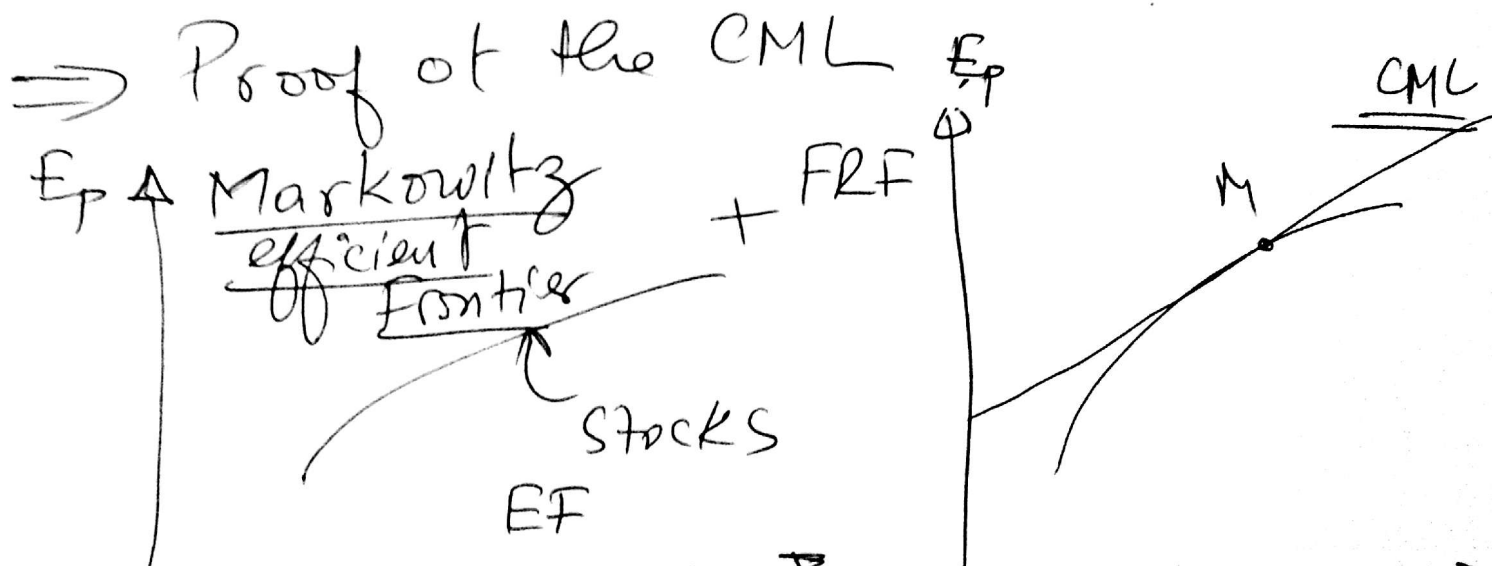
- Long on Stocks
- Short on Bonds

(8)

Comment :

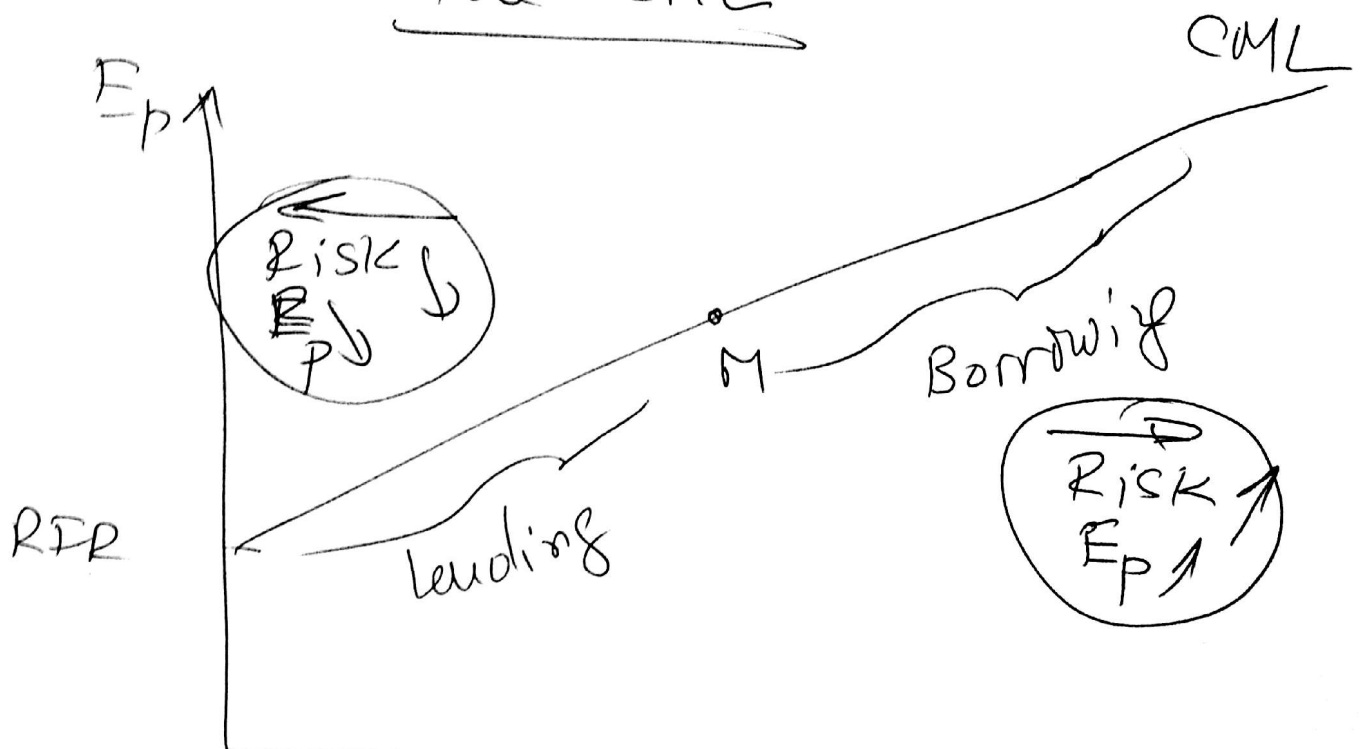
- The ~~AB~~ Introduction of RFR asset is very important for deriving the CML and other Asset Pricing Models.
- If we consider RFR asset, we will have a new Efficient Frontier which is the CML.

Show How the Markowitz efficient Frontier is changing when we introduce RFR Asset? Draw a graph.



Explain a leverage effect on the CML.
(Pages 7 and 8).

The Separation Theorem in the CML



the selection of Portfolios on the CML (Investment Decision) is based on the degree of Risk Aversion σ_p

However, Investment Decision is closely related to financing decision

• if RFR $\downarrow\downarrow\downarrow$ \rightarrow Investors will borrow money \rightarrow leverage to increase E_p and σ_p .

• if RFR $\uparrow\uparrow\uparrow$ \rightarrow Investors will lend and invest more in Bonds at the RFR.

\Rightarrow Investment decision is separated from the financing decision

⊥
Separation Theorem
in the CML

Financing Decision

is a key factor for taking a position along the CML

Ⓜ