THE CAPITAL MARKET LINE

All investors are assumed to have identical (homogeneous) expectations. Hence, all of them will face the same efficient frontier depicted in Fig. Every investor will seek to combine the same risky portfolio B with different levels of lending or borrowing according to his desired level of risk. Because all investors hold the same risky portfolio, then it will include all risky securities in the market. This portfolio of all risky securities is referred to as the market portfolio M. Each security will be held in the proportion which the market value of the security bears to the total market value of all risky securities in the market. All investors will hold combinations of only two assets, the market portfolio and a riskless security.

All these combinations will lie along the straight line representing the efficient frontier. This line formed by the action of all investors mixing the market portfolio with the risk free asset is known as the capital market line (CML). All efficient portfolios of all investors will lie along this capital market line.

The relationship between the return and risk of any efficient portfolio on the capital market line can be expressed in the form of the following equation.

$$\bar{R}_e = R_f + \left[\frac{\bar{R}_e - R_f}{\sigma_m}\right] \sigma_e$$

Where the subscript e denotes an efficient portfolio.

The risk free return R_f represents the reward for waiting. It is, in other words, the price of time. The term $[(Rm - Rf/\sigma_m]$ represents the price of risk or risk premium, i.e. the excess return earned per unit of risk or standard deviation. It measures the additional return for an additional unit of risk. When the risk of the efficient portfolio, σ_e , is multiplied with this term, we get the risk premium available for the particular efficient portfolio under consideration.

Thus, the expected return on an efficient portfolio is :

(Expected return) = (Price of time) + (Price of risk) (Amount of risk)

The CML provides a risk return relationship and a measure of risk for efficient portfolios. The appropriate measure of risk for an efficient portfolio is the standard deviation of return of the portfolio. There is a linear relationship between the risk as measured by the standard deviation and the expected return for these efficient portfolios.

THE SECURITY MARKET LINE

The CML shows the risk – return relationship for all efficient portfolios. They would all lie along the capital market line. All portfolios other than the efficient ones will lie below the capital market line. The CML does not describe the risk – return relationship of inefficient portfolios or of individual securities. The capital asset pricing model specifies the relationship between expected return and risk for all securities and all portfolios, whether efficient or inefficient.

We have seen earlier that the total risk of a security as measured by standard deviation is compared of two components: systematic risk and unsystematic risk or diversifiable risk. As investment is diversified and more and more securities are added to a portfolio, the unsystematic risk is reduced. For a very well diversified portfolio, unsystematic risk trends to become zero and the only relevant risk is systematic risk measured by beta (β). Hence, it is argued that the correct measure of a security‘s risk is beta.

It follows that the expected return of a security or of a portfolio should be related to the risk of that security or portfolios as measured by β. Beta is a measure of the security‘s sensitivity to change in market return. Beta value greater than one indicates higher sensitivity to market changes, whereas beta value less than one indicates lower sensitivity to market changes. A β value of one indicates that the security moves at the same rate and in the same direction as the market. Thus, the β of the market may be taken as one.

The relationship between expected return and β of a security can be determined graphically. Let us consider and XY graph where expected returns are plotted on the Y axis and beta coefficients are plotted on the X axis. A risk free asset has an expected return equivalent to R_f and beta coefficient of zero. The market portfolio M has a beta coefficient of one and expected return equivalent $\overline{R}_m$. A straight line joining these two points is known as the security market line (SML). This is illustrated in Fig. 1

The security market line provides the relationship between the expected return and beta of a security or portfolio. This relationship can be expressed in the form of the following equation:

$$\mathbf{\overline{R}_m - R_f + \beta_i (\overline{R}_m - R_f)}$$

A part of the return on any security or portfolio is a reward for bearing risk and the rest is the reward for waiting, representing the time value of money. The risk free rate, R_f (which is earned by a security which has no risk) is the reward for waiting. The reward for bearing risk is the risk premium. The risk premium of a security is directly proportional to the risk as measured by β. The risk premium of a security is calculated as the product of beta and the risk premium of the market which is the excess of expected market return over the risk free return, that is, $[\overline{R}_m - R_f]$.

Thus,

Expected return on a security = Risk free return + (Beta x Risk premium of market)

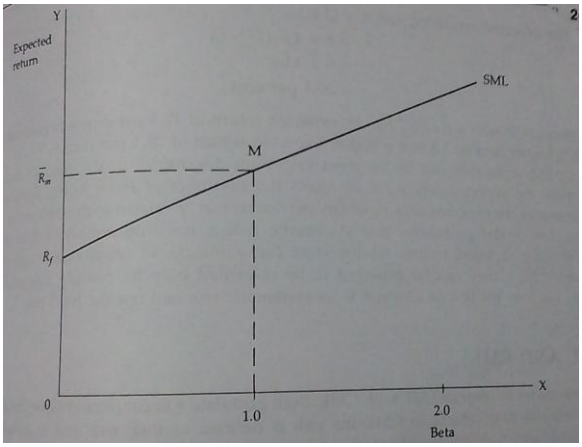

Fig. 1 Security Market Line

CAPM

The relationship between risk and return established by the security market line in known as the capital asset pricing model. It is basically a simple linear relationship. The higher the value of beta, higher would be the risk of the security and therefore, larger would be the return expected by the investors. In other words, all securities are expected to yield returns commensurate with their riskiness as measured by β. This relationship is valid not only for individual securities, but it also valid for all portfolios whether efficient or inefficient.

The expected return on any security or portfolio can be determined from the CAPM formula if we know the beta of that security or portfolio. To illustrate the application of the CAPM, let us consider a simple example. There are two securities P and Q having values of beta as 0.7 and 1.6 respectively. The risk free rate is assumed to be 6 per cent and the market return is expected to be 15 per cent, thus providing a market risk premium of 9 per cent (i.e. $\overline{R}_m - R_f$).

The expected return on security P may be worked out as shown below:

$$\mathbf{\overline{R}_m = R_f + \beta_i \overline{[R}_m - R_f)}$$

$$= 6 + 0.7 (15 – 6)$$

$$= 6 + 6.3 = 12.3 \text{ per cent}$$

The expected return on security Q is

$$\overline{R}_m = 6 + 1.6 (15 – 6)$$

$$= 6 + 14.4$$

$$= 20.4 \text{ per cent}$$

Security P with a β of 0.7 has an expected return of 12.3 per cent whereas security Q with a higher beta of 1.6 has a higher expected return of 20.4 per cent.

CAPM represents one of the most important discoveries in the field of fiancé. It describes the expected return for all assets and portfolios of assets in the economy. The difference in the expected returns of any two assets can be related to the difference in their betas. The model postulates that systematic risk is the only important ingredient in determining expected return. As investors can eliminate all unsystematic risk through diversification, they can be expected to be rewarded only for bearing systematic risk. Thus, the relevant risk of an asset is its systematic risk and not the total risk.

SML AND CML

It is necessary to contrast SML with CML. Both postulate a linear (straight line) relationship between risk and return. In CML the risk is defined as total risk and is measured by standard deviation, while in SML the risk is defined as systematic risk and is measured by β. Capital market line is valid only for efficient portfolios while security market line is valid for all portfolios and all individual securities as well. CML is the basis of the capital market theory while SML is the basis of the capital asset pricing model.

PRICING OF SECURITIES WITH CAPM

The capital asset pricing model can also be used for evaluating the pricing of securities. The CAPM provides a framework for assessing whether a security is underpriced, overpriced or correctly priced. According to CAPM, each security is expected to provide a return commensurate with its level of risk. A security may be offering more returns than the expected return, making it more attractive. On the contrary, another security may be offering less return than the expected return, making it less attractive.

The expected return on a security can be calculating using the CAPM formula. Let us designate it as the theoretical return. The real rate of return estimated to be realsied from investing in a security can be calculated by the following formula.

$$R_i = \frac{(P_1 - P_0) + D_1}{P_0}$$

Where

P_0 = Current market price.

P_1 = Estimated market price after one year

D_1 = Anticipated dividend for the year.

This may be designated as the estimated return.

The CAPM framework for evaluation of pricing of securities can be illustrated with Fig. 2.

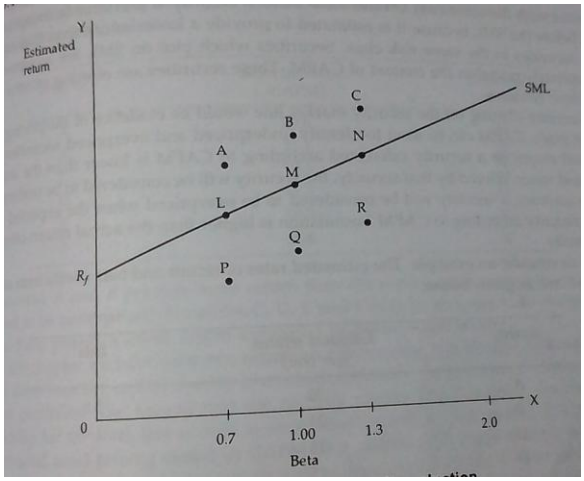

Fig. 2. CAPM and Security Valuation

Fig. 2. shows the security market line. Beta values are plotted on the X axis, while estimated returns are plotted on the Y axis. Nine securities are plotted on the graph according to their beta values and estimated return values.

Securities A, L and P are in the same risk class having an identical beta value of 0.7. The security market line shows the expected return for each level of risk. Security L plots on the SML indicating that the estimated return and expected return on security L is identical. Security A plots above the SML indicating that its estimated return is higher than its theoretical return. It is offering higher return than what is commensurate with its risk. Hence, it is attractive and is presumed to be underpriced. Stock P which plots below the SML has an estimated return which is lower than its theoretical or expected return. This makes it undesirable. The security may be considered to be overpriced.

Securities B, M and Q constitute a set of securities in the same risk class. Security B may be assumed to be underpriced because it offers more return than expected, while security Q may be assumed to be overpriced as it offers lower return than that expected on the basis of its risk. Security M can be considered to be correctly priced as it provides a return commensurate with its risk.

Securities C,N and R constitute another set of securities belonging to the same risk class, each having a beta value of 1.3. It can be seen that security C is underpriced, security R is overpriced and security N is correctly priced.

Thus, in the context of the security market line, securities that plot above the line presumably are underpriced because they offer a higher return than that expected from securities with same risk. On the other hand, a security is presumably overpriced if it plots below the SML because it is estimated to provide a lower return than that expected from securities in the same risk class. Securities which plot on SML are assumed to be appropriately priced in the context of CAPM. These securities are offering returns in line with their riskiness.

Securities plotting off the security market line would be evidence of mispricing in the market place. CAPM can be used to identify and overpriced securities. If the expected return on a security calculated according to CAPM is lower than the actual or estimated return offered by that security, the security will be considered to be underpriced. On the contrary, a security will be considered to be overpriced when the expected return on the security according to CAPM formulation is higher than the actual return offered by the security.

Let us consider an example. The estimated rates of return and beta coefficients of some securities are as given below:

Security	Estimated returns (per cent)	Beta
A	30	1.6
B	24	1.4
C	18	1.2
D	15	0.9
E	15	1.1
F	12	0.7

The risk free rate of return is 10 per cent; while the market return is expected to be 18 per cent.

We can use CAPM to determine which of these securities are correctly priced. For this we have to calculate the expected return on each security using the CAPM equation.

$$\overline{R}_i = R_f + \beta_i [\overline{R}_m - R_f)$$

Given that $R_f = 10$ and $\overline{R}_m = 18$

The equation becomes

$$\overline{R}_i = 10 + \beta_i (18 - 10)$$

The expected return on security A can be calculated by substituting the beta value of security A in the equation. Thus,

$$R_i = 10 + \beta_i (18 - 10)$$
$$= 10 + 12.8$$
$$= 22.8$$

Similarly, the expected return on each security can be calculated by substituting the beta value of each security in the equation.

The expected return according to CAPM formula and the estimated return of each security are tabulated below:

Security	Estimated return (CAPM)	Estimated return
A	22.8	30
B	21.2	24
C	19.6	18
D	17.2	15
E	18.8	15
F	15.6	12

Securities A and B provide more return than the expected return and hence may be assumed to be underpriced. Securities C,D,E and F may be assumed to be overpriced as each of them provides lower return compared to the expected return.

In this chapter we have seen two equations representing risk return relationships. The first of these was the capital market line which describes the risk return relationship for efficient portfolios. The second was the security market line describing the risk return relationship for all portfolios as well as individual securities. This formula is also known as the capital asset pricing model or CAPM. It postulates that every security is expected to earn a return commensurate with its risk as measured by beta. CAPM establishes a linear relationship between the expected return and systematic risk of all assets. This relation can be used to evaluate the pricing of assets.

Difference between CML & SML

CML	SML
The **CML** is a line that is used to show the rates of return, which depends on risk-free rates of return and levels of risk for a specific portfolio	**SML**, which is also called a Characteristic Line, is a graphical representation of the market's risk and return at a given time.
Standard deviation is the measure of risk for CML.	Beta coefficient determines the risk factors of the SML.
The CML measures the risk through standard deviation, or through a total risk factor.	The SML measures the risk through beta, which helps to find the security’s risk contribution for the portfolio.

While the Capital Market Line graphs define efficient portfolios.	Security Market Line graphs define both efficient and non-efficient portfolios.
While calculating the returns, the expected return of the portfolio for CML is shown along the Y- axis. The standard deviation of the portfolio is shown along the X-axis.	SML, the return of the securities is shown along the Y-axis. the Beta of security is shown along the X-axis for SML.
Where the market portfolio and risk free assets are determined by the CML.	All security factors are determined by the SML.
The CML determines the risk or return for efficient portfolios.	SML demonstrates the risk or return for individual stocks.

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1. Markowitz model presumed generally investors are

A. risk averse
B. risk natural
C. risk seekers
D. risk moderate