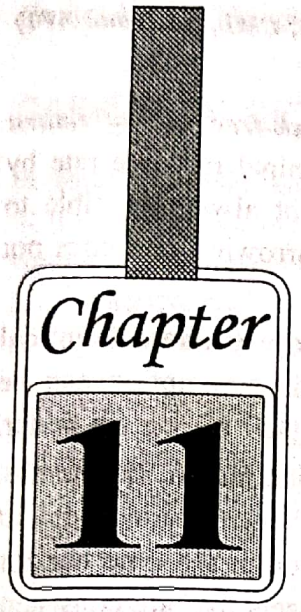


CAPITAL MARKET THEORY
(CAPM, CML, SML AND APT)

The portfolio theory is concerned with establishing guidelines for building up a portfolio of stocks or shares. It focuses on fundamental insights into investor's behaviour and places these insights into a coherent framework for rational analysis and decision-making such that the benefits from these decisions can be maximised, and the risk minimised. But the risk in a portfolio of assets will not be the total of risks of individual investments, it can be more or less than the total. The objective of every investor, however, is to minimise the risk for a given return and Capital Market Theory deals with this subject.

CAPITAL MARKET THEORY

Capital market theory is an extension of the portfolio theory. The portfolio theory explains how rational investors should build efficient portfolio based on their risk return preferences. The major factor that allowed portfolio theory to develop into capital market theory is the concept of a risk-free asset, that is, an asset with zero variance. The assumption of risk-free asset allowed to derive a generalised theory of capital asset pricing under conditions of uncertainty. Capital Market Theory which is popularly, known as 'Capital Asset Pricing Model' (CAPM), explains as how assets should be priced in the capital markets, if, everyone behaved in the way portfolio theory imagined.

ASSUMPTIONS OF CAPITAL MARKET THEORY

When dealing with any theory in science, economics, or finance, it is necessary to articulate a set of assumptions that specify how the world is expected to act. In this connection following are the main assumptions that underline the development of capital market theory.

- ***Investment decision criteria :*** Investors who are risk averse have their portfolio decisions on security, its expected return and standard deviation criterion.

- ***Investors can borrow or lend any amount of money at the risk-free rate of return (RFR).*** Clearly, it is always possible to lend money at the nominal risk-free rate by buying risk-free securities such as government T-bills. It is not always possible to borrow at this risk-free rate, but it is assumed that a higher borrowing rate does not change the general results.
- ***All investors have homogeneous expectations;*** that is, they estimate identical probability distributions for future rates of return. Again, this assumption can be relaxed. As long as the differences in expectations are not vast, their effects are minor.
- ***All investors have the same one-period time horizon*** such as one month, six months, or one year. The model will be developed for a single hypothetical period, and its results could be affected by a different assumption. A difference in the time horizon would require investors to derive risk measures and risk-free assets that are consistent with their investment horizons.
- ***All investments are infinitely divisible,*** which means that it is possible to buy or sell fractional shares of any asset or portfolio. This assumption allows to discuss investment alternatives as continuous curves. Changing it would have little impact on the theory.
- ***There are no taxes or transaction costs involved in buying or selling assets.*** This is a reasonable assumption in many instances. Neither pension fund nor religious groups have to pay taxes, and the transaction costs for most financial institutions are less than 1 percent on most financial instruments. Again, relaxing this assumption modifies the results, but it does not change the basic thrust.
- ***There is no inflation or any change in interest rates,*** or inflation is fully anticipated. This is a reasonable initial assumption, and it can be modified.
- ***Capital markets are in equilibrium,*** this means that we begin with all investments properly priced in line with their risk levels.
- ***Perfect competition in the market,*** that is no individual investor can affect the price of the stock by his buying and selling action and investors in total determine prices by their actions.
- ***All assets are marketable :*** All assets including human capital can be sold and bought in the market.

One may consider some of these assumptions unrealistic and wonder how useful a theory can be derive with these assumptions. In this regard, two points are important. ***First,*** as mentioned, relaxing many of these assumptions would have only a minor effect on the model and would not change its main implications or conclusions. ***Second,*** a theory should never be judged on the basis of its assumptions but rather on how well it explains and helps us predict behavior in the real world. If this theory and the model it implies help to explain the rates of return on a wide variety of risky assets, it is useful, even if some of its assumptions are unrealistic. Such success implies that the questionable assumptions must be unimportant to the ultimate objective of the model, which is to explain asset pricing and rates of return on assets.

CAPITAL ASSET PRICING MODEL (CAPM)

Investors are risk averse. Therefore, they will select a portfolio of securities to take the benefits of diversification. When they are deciding whether or not to invest in a particular security, they want to know how the security will contribute to the risk and expected return of their portfolios. As explained earlier, the total risk of a security consists of both systematic and unsystematic risk. ***Systematic risk,*** which is also called ***market risk or non-diversifiable risk,*** is the portion of a security's risk that cannot be eliminated through diversification. The ***unsystematic risk,*** which is also called ***firm-specific or diversifiable risk,*** is the portion of a security's risk that can be reduced by diversification. Diversification is the act of holding many securities in order to reduce the risk. When a large number of securities enter in a portfolio, many random fluctuations in returns from these securities are automatically set off and, the overall risk of the portfolio is reduced. But systematic risk, with reference to a portfolio, remains the same and is constant irrespective of the number of securities in the portfolio. Therefore, the only effect of a security on the portfolio is through its systematic risk. ***The risk of a diversified portfolio depends upon the systematic risk of the securities in the portfolio.*** The standard deviation of an individual security does not indicate how that security will contribute to the risk and return of a diversified portfolio. So, another measure of risk is needed *i.e.* a measure of a security's systematic risk. The Capital Asset Pricing Model (CAPM) provides this measure which relates to the expected return on a security to its systematic risk.

THE MODEL

The Capital Asset Pricing Model (CAPM) was developed by ***William F. Sharpe,*** the Nobel Laureate, and many financial economists through the sixties. CAPM provides the link between return and non-diversifiable or systematic risk. An investor can use CAPM to assess the extent of additional return over risk-free return for a given level of systematic risk of a risky investment. *The excess return earned over and above the risk-free return is called the risk premium which is the reward for undertaking the risk.* Thus, ***the basic theme of CAPM is that expected return of a security increases linearly with systematic risk, measured by beta.*** It uses the results of capital market theory to derive the relationship between expected return and systematic risk of individual securities portfolios. The CAPM can be expessed in the form of equation as follows :

$$\bar{R} = R_f + \beta (R_m - R_f)$$

Where, $\bar{R}$ = Expected rate of return from any individual security or portfolio of securities.

R_f = Risk-free rate of return.

$\bar{R}_m$ = Expected rate of return on market portfolio.

β = The beta factor *i.e.* market sensivity index or measure of systematic risk of individual security or portfolio of securities.

For example, if the Future Capital Holdings has invested in equity shares of a blue chip company and its.

Risk free return (R_f) = 9%

Expected market return (R_m) = 16%

Beta factor is = 0.8

The expected rate of return as per CAPM will be–

$$\begin{aligned}\bar{R} &= R_f + \beta (R_m - R_f) \\ &= 9 + 0.8 (16 - 9) \\ &= 9 + 0.8 \times 7 \\ &= 9 + 5.6 = 14.6\%\end{aligned}$$

CAPM explains the behaviour of security prices and provides a mechanism whereby investors could assess the impact of a proposed security investment on the overall portfolio risk and return. It suggests that the prices of securities are determined in such a way that the risk premium or excess returns are proportional to systematic risk, which is indicated by the beta coefficient. The model is used for analysing the risk-return implications of holding securities. CAPM refers to the manner in which securities are valued in line with their anticipated risks and returns. A risk-averse investor prefers to invest in risk-free securities. For a small investor having few securities in his portfolio, the risk is greater. To reduce the unsystematic risk, he must build up well-diversified securities in his portfolio.

INFORMATION REQUIRED FOR CAPM

The CAPM model reveals that the expected rate of return of a security consists two parts *i.e.* (i) risk-free rate of return (R_f) or price of time, and (ii) risk premium ($R_m - R_f$) β or (price of risk × amount of risk). The risk premium is equal to the difference between the expected market return and risk-free rate of return multiplied by the beta factor. It shows that risk premium varies directly with the beta factor (the systematic risk), and therefore the value of expected rate of return of a security (R) depends upon the beta factor (β). The higher the beta factor, greater is the expected rate of return. Thus, it is clear that the information related to the following three aspects are needed to apply the CAPM :

- Risk free rate (R_f)
- Risk premium ($R_m - R_f$)
- Beta (β)

Risk Free Rate (R_f)

The rate of return available on assets like treasury T-bills, money market funds or bank deposits is taken as the proxy for risk-free rate. The maturity period of T-bills and bank deposits is taken to be less than one year, usually 364 says. Such assets have very low or negligible default risk and interest rate risk. However, under inflationary conditions, they are riskless in nominal terms only. In fact, the real return (nominal return minus inflation rate) may become zero, even negative, when inflation picks up.

Risk Premium on Market Portfolio

Market risk premium or risk premium on market portfolio is the difference between the expected return on the market portfolio and the risk-free rate of return. The CAPM holds that in equilibrium, the market portfolio is the unanimously desirable risky portfolio. It contains all securities in exactly the same proportion in which they are supplied, that is, each security is held in a proportion to its market value. It is an efficient portfolio which entails neither lending nor borrowing. The risk premium on the market portfolio is proportional to its risk (σ_m^2) and the degree of risk aversion of the average investor.

Beta (β)

It measures the risk (volatility) of an individual asset relative to the market portfolio. Assets with beta less than one are called defensive assets, whereas, assets with beta greater than one are called aggressive assets. Risk-free assets have a beta equal to zero. The return on an asset with negative beta moves in the opposite direction. Beta estimation has been discussed in detailed in the previous chapter.

ASSUMPTIONS

The CAPM is based on several assumptions which are as follows–

- ***Market is Perfect :*** This means that all assets are marketable and that there are no transaction costs or taxes.
- ***Risk-free Rate :*** There is a single risk free rate of return (*i.e.*, the R_f is the same for all investors). Investors can freely borrow or invest at such risk free rate.
- ***Homogenous Expectations :*** Investors have homogeneous expectations about return. Return in turn is dependent on dividends and capital gains. Inflation and its effect on dividends and capital gains are ignored.
- ***Time Period :*** Forecasts are for one time period only.
- ***Rational Investors :*** All investors are rational, that is, for a higher risk, they expect a higher return.
- ***Divisible :*** All stocks are infinitely divisible, and it will be possible for investors to invest in a fraction of a stock.
- ***Diversification :*** Investors hold well-diversified portfolios.

CAPITAL MARKET LINE (CML)

The Capital Asset Pricing Model (CAPM) consists of two elements : the Capital Market Line (CML) and the Security Market Line (SML). ***The Capital Market Line (CML) defines the relationship between total risk and expected return for portfolios consisting of the risk-free asset and the market portfolio.*** If all the investors hold the same risky portfolio, then in equilibrium it must be the market portfolio. CML generates a line on which efficient portfolios can lie. Those which are not efficient will however lie below the line. Portfolios having maximum return at each level of risk (standard deviation) are the efficient portfolios.

Thus, the ***CML represents the equilibrium condition that prevails in the market for portfolios consisting of risk-free and risky investments.*** All combinations of risky and risk-free investments are bound by the CML and in equilibrium, all investors will end up with portfolio on the CML. It says that the expected return on a portfolio is equal to the risk-free rate plus a risk premium. The risk premium is equal to the market price of risk times the quantity of risk. So, the CML shows the trade off between the expected returns and risk for portfolios and the risk is measured by the standard deviation of the portfolio. The equation for CML is :

$$\bar{R}_p = R_f + (R_m - R_f) \frac{\sigma_p}{\sigma_m}$$

Where, $\bar{R}$ = Expected return of a portfolio
R_f = Risk-free rate of interest
R_m = Return on the market portfolio
σ_p = Standard deviation of the portfolio
σ_m = Standard deviation of the market portfolio

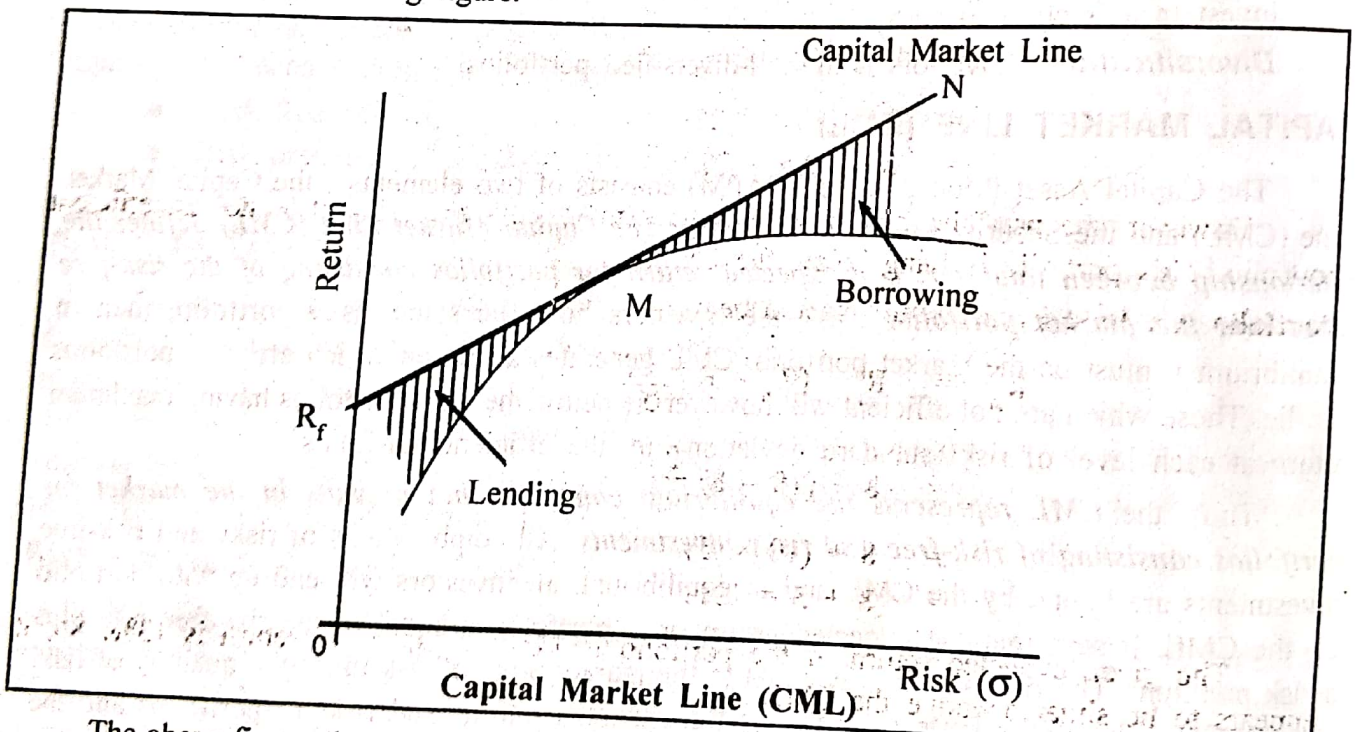
The Slope of CML : The slope of CML is find out by using the following formula–

$$(R_m - R_f)/\sigma_m$$

In the above formula of slope of CML, the numerator is the excess of market return over the risk-free return. It is a measure of the risk premium or the reward for bearing the risky market portfolio instead of holding risk-free investments. In the slope of the CML, the denominator is the risk of the market portfolio. So, the slope measures the reward per unit of market risk. In other words, the slope of CML measures the additional return needed to compensate for a unit change in risk. The following are the ***main characteristic of CML :***

- Portfolio *M* (tangent point) is the market portfolio and is the optimum combination of risky investments.
- Only efficient portfolios consisting of the risk-free investments and the market portfolio *M* lie on the CML.
- CML must always be upward sloping because the price of risk must be positive. A risk averse investor will not invest unless expected to be compensated for risk. The greater the risk, the larger would be the expected return.

The CML indicates the required rate of return for each risk level. The CML has been presented in the following figure.



Capital Market Line (CML)

The above figure shows that with the introduction of the risk-free investments, the investor can select the portfolio on the CML which represents the combination of risk-free and risky investments. This is possible with lending or borrowing at the risk-free rate of interest and the purchase of efficient portfolio *M*. The particular portfolio, an investor will select on the CML,

will depend upon his risk preference. The part of the CML from R_f to *M* shows investment in risk-free securities and is called a ***lending portfolio.*** On this part of the CML, the investor is willing to lend a portion of his funds at risk-free rate. The portion of the CML beyond *M* is known as ***borrowing portfolio.*** In this case, the investor would buy the portfolio *M* out of his funds and would borrow funds at risk-free rate to buy more of the portfolio *M.* The following illustration 1 explains the concept and application of CML.

Illustration 1 : The following portfolios are available to an investor :

Portfolio	*Expected Return*	*Risk (σ)*
A	14.0%	2%
B	18.0%	5%
C	30.5%	9%

Find out whether these portfolios are efficient or not, given that the risk-free interest rate is 8%. Return of the market portfolio is 18% and the risk of the market portfolio is 4%.

Solution

In order to be an efficient portfolio, it must follow the CML pattern. ***Out of the three portfolios, the portfolio B is not an efficient one.*** Because it has the same rate of the return as that of the market portfolio, *i.e.,* 18% but its risk (5%) is more than the risk of the market portfolio (4%). In order to be an efficient portfolio, its return must be :

$$\bar{R}_B = R_f + (R_m - R_f)\frac{\sigma_B}{\sigma_m}$$

$$= 8 + (18 - 8)\frac{5}{4}$$

$$= 8 + (10 \times 1.25)$$

$$= 8 + 12.5 = 20.5\%$$

However, the portfolio has an expected return of 18% only. So, it is not an efficient portfolio. This portfolio is lying below the CML.

Portfolio A : Its expected return should be :

$$\bar{R}_A = R_f + (R_m - R_f)\frac{\sigma_A}{\sigma_m}$$

$$= 8 + (18 - 8)\frac{2}{4}$$

$$= 8 + (10 \times .5)$$

$$= 8 + 5 = 13\%$$

The given expected return of the portfolio is 14% but its given return is 13%. So, it appears to be situated above the CML.

Portfolio C : Its expected return is :

$$\bar{R}_C = R_f + (R_m - R_f)\frac{\sigma_C}{\sigma_m}$$

$$= 8 + (18 - 8)\frac{9}{4}$$
$$= 8 + (10 \times 2.25)$$
$$= 8 + 22.5 = 30.5\%$$

The expected return of portfolio C is same as given. So, this portfolio is lying on the CML, and is therefore, an efficient portfolio.

It may be noted that in an efficient capital market, portfolios A, and B cannot persist. The investors would tend to buy portfolio A and sell portfolio B. Consequently, the prices of the constituent securities of portfolio A would increase and that of portfolio B would decrease. The result would be that the expected return of the portfolio A would tend to decrease from 14% to 13% while that of portfolio B would tend to increase from 18% to 20.5%. Thus, CML opens up the possibilities of whole new investment opportunities.

It is worth mentioning here that CAPM risk return relationship is separate and distinct from risk return relationship of individual securities as represented by CML. An individual security's expected return and systematic risk should lie on the CAPM but below the CML. In contrast the riskless statistics of all portfolios, even the inefficient ones should plot on the CAPM. The CML will never include all points, its efficient portfolios, inefficient portfolios and individual securities are placed together on one graph. The individual assets and the inefficient portfolios should plot as points below the CML because their total risk includes diversifiable risk.

Illustration 2 : The expected return of the market portfolio is 14% and the risk-free rate is 10%. The standard deviation of the market portfolio is 28% whereas the standard deviation of the portfolio of an investor is 37%. Find out the expected return of the investor as per CML.

Solution

Expected return as per CML is :

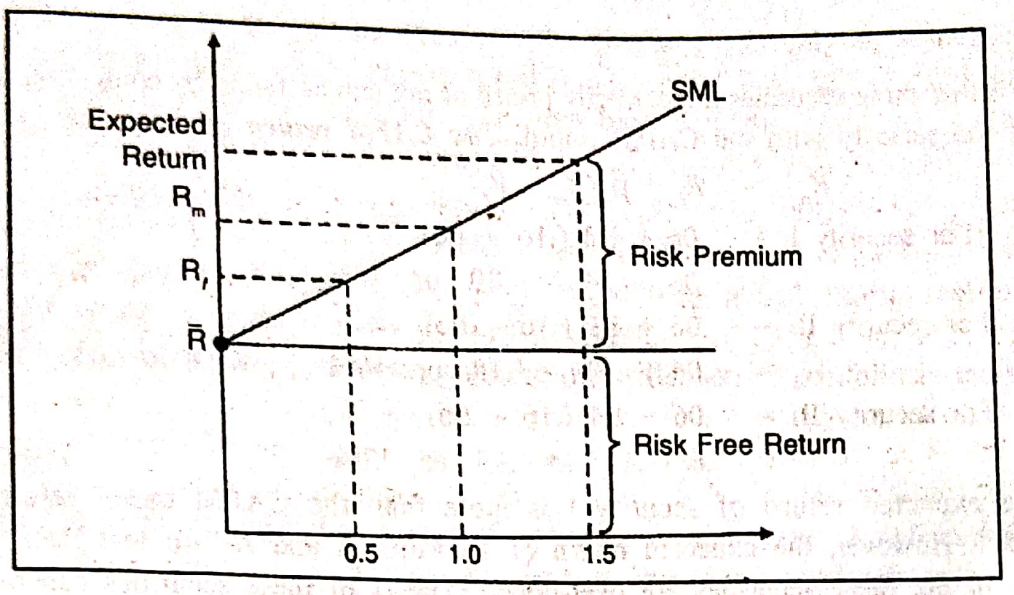
$$\bar{R}_P = R_f + (R_m - R_F)\frac{\sigma_P}{\sigma_m}$$
$$= .10 + (.14 - .10)\frac{37}{28}$$
$$= 15.28\%$$

So, the expected return of the investor is 15.28%

SECURITY MARKET LINE (SML)

A graphical representation of CAPM is the Security Market Line. (SML). This line indicates what rate of return is required to compensate for a given level of risk. Having known how expected return is computed, we can proceed to calculate the required return of a stock for various levels of β including for a beta of zero as risk free investments have a beta of zero. If we plot this graphically, with required return on the Y-axis and β on the X-axis, we get an upward sloping line.

This line points to $R_m - R_f$, *i.e.*, the risk-premium element, and the fact that higher is the β value for a security, higher would be its risk premium relative to the market. This upward sloping line is called the ***Security Market Line*** [*See Chart on next page*]. It measures the relationship between systematic risk and return.



APPLICATION OF SML

When individual securities and portfolios are priced correctly, they lie exactly on the SML. Securities plotting of the SML indicate mispricing of securities by the market. ***Securities that plot above the SML are undervalued and hence attractive because they offer higher expected return than the required rate of return.*** The buying pressure for such securities will push up their price and lower the return until they are correctly priced. On the other word, ***securities that plot below SML are overpriced and hence unattractive as the expected rate of return is lower than the required rate of return.***

In a well functioning market, SML can be used to find out the 'fair' rate of return that a security should offer in view of its beta factor, risk-free rate and the market rate of return. In other words, ***'the fair return' as predicted by SML for a given risk can be obtained by mixing the risk-free asset and the market portfolio in the right proportion.*** This 'fair' rate of return can be compared with the actual rate of return on that security. If the 'fair' return is less than the actual return, the security is under-priced. If the 'fair' return is more than the actual, the security is over priced. This has been explained with the following illustration.

Alpha Factor, (α) : ***The difference between the fair rate of return of a security and the expected rate of return of the security, is known as the Alpha factor, (α).*** It shows as to how much more or less the security is earning as compared with the expected rate of return (in view of its risk, the beta factor).

Illustration 3 : Following information is available in respect of certain securities :

Security	β	*Expected Return*
I	1.4	22%
II	1.2	16%
III	1.1	14%

The market return is 16% and the risk-free rate is 6%. Find out whether these securities are *correctly priced or not.* Also find out the α (Alpha) for these securities.

Solution

Whether these securities are correctly priced or not can be found by comparing the expected return of the security with the CAPM return. ***The CAPM return of*** these securities are :

$$\bar{R}_p = R_f + \beta\,(R_m - R_f)$$

For security I = .06 + 1.4 (.16 – .06)
= .06 + .14 = .20 or 20%

For security II = .06 + 1.2 (.16 – .06)
= .06 + .12 = .18 or 18%

For security III = .06 + 1.1 (.16 – .06)
= .6 + .11 = .17 or 17%

The expected return of security I is more than the CAPM based return, so it is under-prised. However, the expected return of securities II and III are less than the CAPM based return. So, these securities are over-priced. The α of these securities can be found as follows :

Alfa factor (α) = Expected Return – CAPM based Return
For security I = (22% – 20%) = 2%
For security II = (16% – 18%) = –2%
For security III = (14% – 17%) = –3%

DIFFERENCE BETWEEN SML AND CML

The SML is very similar to the Capital Market Line (CML) discussed above, but there are differences between the two. The main points of differences are as under :

(1) **Measure of Risk :** The basic deference between the two is the measure of risk. The CML measures the total risk of a portfolio and is measured in terms of σ. On the other hand, the SML is concerned only with the systematic risk of a security as measured by the beta factor β. So, in CML, return is plotted against the total risk of the portfolio, whereas in SML, the return in plotted against only that risk which cannot be diversified away.

(2) **Efficient Portfolio :** All the portfolios lying on the CML are the efficient portfolios and the inefficient portfolios lie below the CML. However, the SML shows only those securities which are correctly priced in view of the systematic risk associated with the security. SML provides a benchmark for evaluation of investment performance. It provides the minimum required rate of return that will compensate the investor for risk taken.

BENEFITS OF CAPM

CAPM model of portfolio management is used by investors because of its following inherent merits–

(1) **Risk Adjusted Return :** CAPM provides a reasonable basis of estimating the required return on an investment after taking into account the risk inbuilt into the investment. Hence, it can be used as the risk adjusted discount rate in capital budgeting.

(2) **No Dividend Company :** This method is useful in computing the cost of equity of a company, which does not actually declare any dividend.

(3) **Under Valued or Over Valued Stocks :** The CAPM is not only an academic model. It can put to practical use to decide whether one shoud buy, sell or hold shares by comparing the required rate of return with the expected return. The strategy would be–

CAPM (%) < $\Sigma \bar{R}$ — Buy
CAPM (%) > $\Sigma \bar{R}$ — Sell
CAPM (%) = $\Sigma \bar{R}$ — Hold

(4) **Analysis of Risk of Project :** The investment in risky project having real assets can be evaluated of its worth in view of expected return.

(5) **Minimisation of Risk :** CAPM suggests the diversification of portfolio in minimisation of risk.

LIMITATIONS

The CAPM provides a useful technique of measuring the risk factor as well as the required rate of return. It is a useful model in dealing with the risk. However, it suffers from the following limitations :

(1) **Reliability of Beta :** A statistically reliable beta factor might not exist for the shares of many companies. Since beta is at the heart of CAPM, it may not be possible to figure out the cost of equity of all companies using CAPM. Further all the limitations that apply to Beta factor applies to CAPM as well.

(2) **Other Risks :** By concentrating only on systematic risk, other aspects of risk are excluded. These unsystematic elements will be of relevance to those shareholders who do not hold a well-diversified portfolio.

(3) **End and Not Means :** The model focuses only on return and not how return is earned. It assigns equal prominence to both capital gains and dividends whereas one may be better than the other on account of differential taxation.

(4) **Information Collection :** It is difficult to determine some crucial information such as risk free interest rate and the expected return on market portfolio. For one, there are multiple risk free rates. For another, markets are volatile and it varies over time.

Illustration 4 : What is the required rate of return under the Capital Asset Pricing Model in situations I, II and III respectively?

Situation	*Risk-free return*	*Return on market portfolio*	*Beta (β)*
I	6	10	0.90
II	7	11	1.40
III	5	9	1.00

We know that–

$$\bar{R} = R_f + \beta(R_m - R_f)$$

In situation I, $\bar{R}$ = 6% + 0.9 (10% – 6%) = 9.6%
II, $\bar{R}$ = 7% + 1.4 (11% – 7%) = 12.6%
III, $\bar{R}$ = 5% + 1.0 (9% – 5%) = 9%

The greater the beta, the higher would be the risk and the greater the risk premium. This pushes the required rate of return upward.

Illustration 5 : Aditya enterprise has a beta of 1.5. The risk free rate is 7 per cent and the expected return on the market portfolio is 14 per cent. The company presently pays a dividend of Rs. 2.50 per share and investors expect a growth in dividend of 12 per cent per annum for many years to come. Compute the required rate of return on the equity according to CAPM. What is the present market price of the equity share assuming the computed return as required return?

Solution

According to CAPM model–

$$\bar{R} = R_f + \beta_i (R_m - R_f)$$
$$\bar{R} = 7 + 1.5 (14 - 7)$$
$$\bar{R} = 7 + 10.5 = 17.5$$

The return computed is taken as required rate of return then–

$$P = \frac{D_0 (1 + g)}{r - g}$$
$$= \frac{\text{Rs. } 2.5 (1 + .12)}{.175 - .12}$$
$$= \frac{2.8}{.055} = 50.91$$

Present market price is Rs 50.91

Illustration 6 : Mr. Obama is considering an investment in the share of HUL Ltd. Obama expects HUL Ltd. to earn a return of 17 per cent in the next year. HUL's beta is 1.3, risk-free return is 7 per cent and market return is 15 per cent. Should Mr. Obama invest in the HUL Ltd.?

What should Obama do if beta is 1.1 ? Assume that other values have not changed.

Solution

The equilibrium return according to CAPM–

$$\bar{R} = R_f + \beta [R_m - R_f]$$
$$= 7 + 1.3 (15 - 7)$$
$$= 7 + 10.4 = 17.4\%$$

The actual return is less than the equilibrium return *i.e.* 17.0 < 17.4, he should not buy the stock. The stock is overvalued and its price may fall.

When beta is 1.1

$$\bar{R} = R_f + \beta [R_m - R_f]$$
$$= 7 + 1.1 (15 - 7)$$
$$= 7 + 8.8 = 15.8\%$$

Now, the HUL Ltd. is expected to earn 17% which is greater than the equilibrium return of 15.8%. HUL Ltd. share is a good buy.

ARBITRAGE PRICING THEORY (APT)

Arbitrage pricing theory is one of the tools used by the investors and portfolio managers. The capital asset pricing model (CAPM) explains the returns of the securities on the basis of their respective betas. According to the previous models, the investor chooses the investment

on the basis of expected return and variance. The alternative model developed in asset pricing by **Stephen Ross** is known as Arbitrage Pricing Theory. The APT theory explains the nature of equilibrium in the asset pricing in a less complicated manner with fewer assumptions compared to CAPM.

Arbitrage is a process of earning profit by taking advantage of differential pricing for the same asset. The process generates riskless profit. In the security market, it is of selling security at a high price and the simultaneous purchase of the same security at a relatively lower price. ***Thus, arbitrage refers to buying in the low priced market and selling in the high priced one to gain from price differences for bringing about equilibrium in the market price of a security.*** Since the profit earned through arbitrage is riskless, the investors have the incentive to undertake this whenever an opportunity arises. However, the buying and selling activities of the arbitrageur reduces and eliminates the profit margin, and thus, bringing the market price to the equilibrium level.

ASSUMPTIONS

The APT theory is based on several assumptions which are as follows :

- The investors have homogenous expectations.
- The investors are risk averse and utility maximisers.
- A perfect competition prevails in the market and there is no transaction cost.
- The security returns are generated according to factor model.
- Risk-return analysis is not the basis.

The APT theory does not assume (i) single period investment horizon, (ii) no taxes (iii) investors can borrow and lend at risk-free rate of interest and (iv) the selection of the portfolio is based on the mean and variance analysis. These assumptions are present in the CAPM theory.

THE APT MODEL

According to **Stephen Ross,** returns of the securities are influenced by a number of macro economic factors which explains the risk / risk premium relationship of a particular security. The objective of security analysis is to identify these factors in the economy and the sensitiveness of security return to movements in these factors. A formal statement of such relationship is termed as a factor model of security returns. ***The APM, which was developed by Stephen Ross (1976), has given a four factors model which explains the risk / risk premium relationship of a particular security as follows–***

Basically, CAPM says that :

$$\bar{R} = R_f + \lambda \beta$$

Where λ is the average risk premium $= R_m - R_f$

However, CAPM holds that :

$$\bar{R} = \lambda_0 + \lambda_1 \beta_1 + \lambda_2 \beta_2 + \lambda_3 \beta_3 + \lambda_4 \beta_4$$

When λo is not given, the **APT equilibrium model with riskless asset** can be found out using the formula–

$$\bar{R} = R_f + (\beta_1 \lambda_1 + \beta_2 \lambda_2 + \beta_3 \lambda_3 + \beta_4 \lambda_4)(R_m - R_f)$$

Where λ_1, λ_2, λ_3, and λ_4 are the average risk premium for each of the four factors in the model and β_1, β_2, β_3, and β_4 are measures of the sensitivity of the particular security to each of the four factors.

FACTORS

In APT Model, the basic question is what are these factors? They are the underlying economic forces that have the primary influences on the stock market. Several factors appear to have been identified as being important. Some of these factors, such as inflation and money supply, industrial production and personal consumption do have aspects of being interrelated. In particular, the researchers have identified the following factors–

- Changes in the level of industrial production in the economy.
- Changes in the shape of the yield curve.
- Changes in the default-risk premium (*i.e.* changes in the return required on bonds with different perceived risk of default.).
- Changes in the inflation rate.
- Changes in the real interest rate.
- The level of personal consumption.
- The level of money supply in the economy.

APT AND CAPM

The CAPM explains the behaviour of share prices and asset prices. However, some of the assumptions underlying CAPM are hypothetical and do not hold good in reality. As an alternative, the Arbitrage Pricing Theory (APT) has been developed by Stephen Ross. The APT is based on the assumption that investors would arbitrage in a way that any difference in the expected returns on assets has some degree of risk. The expected return of a security, in case of CAPM, is dependent on the market sensivity index. So, there is one factor affecting the expected return of the security *i.e.* its market sensivity. However, the APT suggests that return of a security is linearly related to a number of factors including the risk-free rate of return. Thus, both APT and CAPM model are different and similar in some respects which are as follows–

(1) The simplest form of ***APT model is consistent with the simple form of the CAPM model.*** When only one factor is taken into consideration, the APT can be stated as capital market line equation which is similar to the CAPM model.

(2) ***APT is more general and less restrictive than CAPM.*** In APT, the investor has no need to hold the market portfolio because it does not make use of the market portfolio concept. The portfolios are constructed on the basis of the factors to eliminate arbitrage profits. APT is based on the law of one price to hold for all possible portfolio combinations.

(3) The APT model takes into account of the ***impact of numerous factors on the security.*** The macro economic factors are taken into consideration and it is closer to reality than CAPM.

LIMITATIONS OF APT

The following are the limitations of Asset Pricing Theory (APT) model

(1) **Undefined Factors :** In APT model, the factors are not well defined. Hence, the investor finds it difficult to establish equilibrium relationship. The well defined market portfolio is a significant advantage of the CAPM leading to the wide usage of the model in the stock market.

(2) **Lack of Consistency :** The factors that have impact on one group of securities may not affect another group of securities. There is a lack of consistency in the measurements of the APT model.

(3) **Lack of Independence :** Further, the influences of the factors are not independent of each other. It may be difficult to identify the influence that corresponds exactly to each factor. Apart from this, not all variables that exert influence on a factor are measurable.

Illustration 7 : Estimate the stock return by using the CAPM model and the arbitrage model. The particulars are given below–

(i) The expected return of the market is 15 per cent and the equity's beta is 1.2. The risk free rate of interest is 8 per cent.

(ii)

Factor	*Market price of Risk*	*Sensitivity Index*
Inflation	6%	1.1
Industrial Production	2%	0.8
Risk premium	3%	1.0
Interest rate	4%	– 0.9

What explanations can you offer to explain the difference in two estimates?

Solution

CAPM Model

$$\bar{R} = R_f + \beta_1 (R_m - R_f)$$
$$= .08 + 1.2 (.15 - .08)$$
$$= .08 + .084 = .164 \text{ or } 16.4\%$$

APT Model

$$\bar{R} = \lambda_0 + \lambda_1 \beta_1 + \lambda_2 \beta_2 + \lambda_3 \beta_3 + \lambda_4 \beta_4$$

Since λo is not given, the APT equilibrium model with riskless asset can be found out using the formula–

$$\bar{R} = R_f + (\beta_1 \lambda_1 + \beta_2 \lambda_2 + \beta_3 \lambda_3 + \beta_4 \lambda_4) (R_m - R_f)$$
$$= .08 + (.06 \times 1.1 + .02 \times .8 + .03 \times 1.0 + .04 \times - .9) (.15 - .08)$$
$$= .08 + (.066 + .016 + .03 - .036) .07$$
$$= .08 + .005$$
$$= .085 \text{ or } 8.5\%$$

The rates of return differ in the CAPM and APT models because the variables used are entirely different. The return is low according to APT model because interest rate has a negative effect on the return.

Illustration 8 : Birla is an investment analysis for share of REL. The results of the analysis are as follows. The market price of risks or β and sensitivities for the particular stock are given below. $\lambda_0 = 5$.

Factor	λ	β
Interest rate risk	.9	.9
Purchasing power risk	.9	1.8
Management risk	1.3	1.6
Market risk	.8	– 1.75

The probability of getting return on REL share is given below.

Return	*Probability*
15%	40%
20%	30%
10%	20%
8%	10%

Can an investor purchase share of REL ?

Solution

The expected return of the REL share is–

$$\bar{R} = \lambda_0 + \lambda_1 \beta_1 + \lambda_2 \beta_2 + \lambda_3 \beta_3 + \lambda_4 \beta_4$$

$$= 5 + (.9 \times .9) + (.9 \times 1.8) + (1.3 \times 1.6) + (.8 \times -1.75)$$

$$= 5 + .81 + 1.62 + 2.08 - 1.4$$

Return according to the model = 8.11

The probable return $R = (15 \times .4) + (20 \times .3) + (.10 \times .2) + (8 \times .1)$

$= 14.8$

Since the probable return is higher than the return according to the model, the share of REL can be purchased.

SOLVED PROBLEMS

Problem 1 : The beta co-efficient of security 'A' is 1.6. The risk-free rate of return is 12% and the required rate of return is 18% on the market portfolio. If the dividend expected during the coming year is Rs. 2.50 and the growth rate of dividend and earnings is 8%, at what price should the security 'A' can be sold based on the CAPM.

Solution

Expected Rate of Return is calculated by applying CAPM formula–

$$\bar{R} = R_f + \beta (R_m - R_f)$$

$$= .12 + 1.6 (.18 - .12) = .12 + .096 = 216 \text{ or } 2.16\%$$

Price of security 'A' is calculated with the use of dividend growth model formula–

$$R = \frac{D_1}{P_0} + g$$