LPCPS
LUCKNOW PUBLIC COLLEGE OF PROFESSIONAL STUDIES

B.Com. (Hons.) Course

Semester – V

Paper: Security Analysis and Portfolio Management

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CHAPTER-13

CAPITAL MARKET THEORY

Structure:-

13.0 LEARNING OBJECTIVES

After reading this chapter, you will be able to:-

- Describe how assets should be priced in capital market
- Explain the assumptions of the capital market theory
- Describe the problems associated with the empirical testing of arbitrage pricing theory
- Discuss the expected return of all assets and portfolios of assets in the economy.

13.1 INTRODUCTION

In portfolio selection, not only returns but risks are also to be considered as in the case of single investments. In aggregation of risk two and two does not always make it four as suggested

by Markowitz in his portfolio model. This model was mechanically so complex that it could not be practically adopted either by practitioners or by academicians. As a result the capital asset pricing model was developed. The risks in a portfolio of asset 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 minimize the risk for a given return and capital market theory deals with this subject.

13.2 CAPITAL MARKET THEORY

Capital market theory is an extension of the portfolio theory of Markowitz. Markowitz used mathematical programming and statically analysis in order to arrange for the optimum allocation of assets within portfolio. To reach this objective he generated portfolios with a reward-risk perspective. In essence, his model is a theoretical framework for the analysis of risk return preferences of an investoror analyst. Thus, the portfolio theory explains how rational investors should build efficient portfolios based on their risk return preferences. Capital market theory incorporates a relationship, explaining how assets should be priced in capital market. The investments market is a very complex market. Any model or theory which deals with pricing of assets, must remove these complexities. A few of asset market complexities are commissions, taxes, short selling rules, margin requirements etc.

Any capital asset pricing model must assume away these complexities as these have only a small effect on the investor's behavior. The capital market theory is thus, based on the following assumptions:

13.3 ASSUMPTIONS OF CAPITAL MARKET THEORY

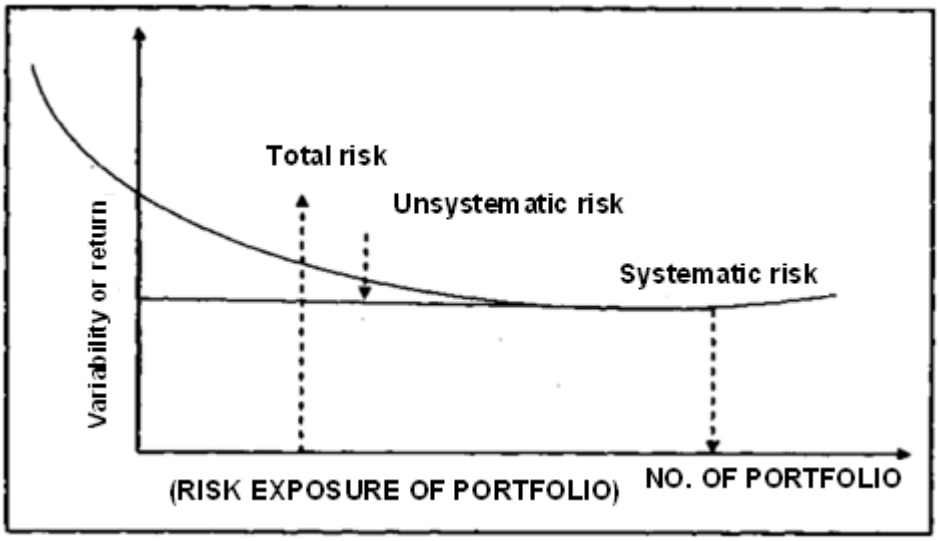
1. Investors base their portfolio investment decisions on security, its expected return and standard deviation criteria.
2. The capital assets are infinitely divisible. The investors may borrow and/or lend without limit in infinitely divisible units regardless of the size of their wealth.
3. Investors have identical expectations about future outcomes over a one period time horizon. As stated earlier, these outcomes are expected returns, the variance of the returns, and the correlation matrix representing the correlation structure between all pairs of stocks.

4. Capital markets are in equilibrium.
5. There is perfect competition in the market. No individual investor can affect the price of the stock by his buying or selling action and investors in total determine prices by their actions.
6. There are no transactions costs i.e. cost of buying or selling any asset. To include transaction costs in the mechanism adds a great deal of complexities. Whether it is worthwhile introducing this complexity depends on the importance of transaction costs to investors 'decisions'. These costs are probably of minor importance.
7. Personal income tax is assumed to be nil.
8. Investors are risk averse and maximize expected utility of wealth.
9. Investors can resort to short selling of shares without any limit.
10. Investors can borrow/lend the desired amount at risk free rate of interest.
11. All the assets are marketable. All assets including human capital can be sold and bought in the market.

It is clear after going through the above mentioned assumptions do not hold good in the real world and are untenable.

13.6 CAPITAL ASSET PRICING MODEL (CAPM)

William F. Sharpe developed the capital asset pricing model (CAPM). He emphasized that the risk factor in portfolio theory is a combination of two risks i.e. systematic risk and unsystematic risk. Thesystematic risk attached to each of the security is the same irrespective of any number of securities in the portfolio. The total risk of portfolio is reduced with increase in the number of stocks, as a result of decrease in the unsystematic risk distributed over number of stocks in the portfolio. This is shown in thefollowing figure:



(RISK EXPOSURE OF PORTFOLIO)

A risk averse investor prefers to invest in risk free securities. A small investor having few securities in his portfolio has greater risk. To reduce the unsystematic risk, he must build up a while diversified portfolio of securities. A diversified and balanced portfolio of all securities will bring an investor's risk in the stock market as w whole.

Sharpe assets in CAPM that risky portfolios do not pay more than the safe one. The systematic risk of two portfolios remains the same. To the rational investors, it makes no difference that the stocks in one portfolio are individually riskier than other stocks because successive stock price changes are identically distributed, independent of random variables. An individual is assumed to rank alternatives inhis order of preference. However, due to operating constraints e.g. limited finance he can avail only some of the alternatives. As such an individual chooses among the logically possible in the highest on his ranking. In other words an individual acts in a way in which he can maximize the return on his investment under conditions of risk and uncertainty.

Thus, the CAPM is a linear relationship in which the required rate of return K from an asset is determined by that asset's systematic risk. The CAPM is represented mathematically by the following equations:

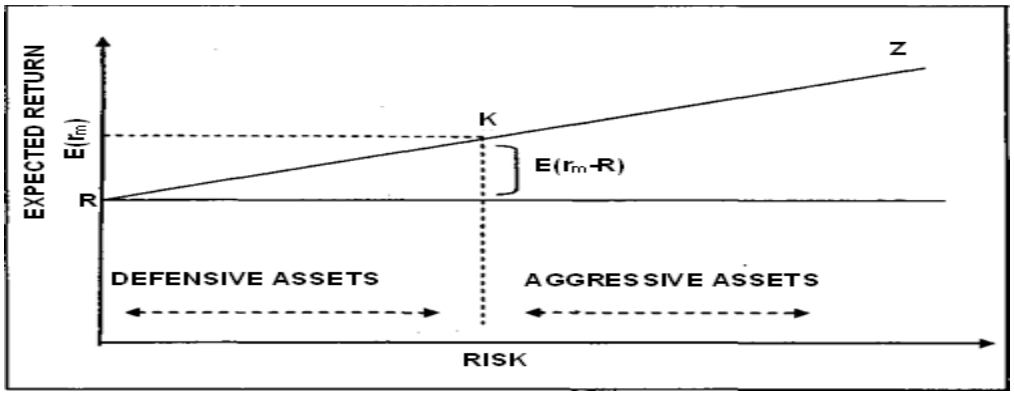
$K_{„} = R + [E(r_m) - R)b_n$

Where b_n = independent variable representing the systematic risk of the nth risk.

K = dependent variable measuring the required rate of return.

The CAPM interests the vertical axis at the risk less rate R, the quantity $E(r_m)$ - R is the slope of the CAPM.

Capital Asset Pricing Model is represented by a CAPM line drawn on risk-return space. The CAPM relates a required rate of return to each level of systematic risk. The following figure portrays it graphically.



Point K represents the market portfolio and point R the risk less rate of return. Line RKZ represents the preferred investment strategies, showing alternative combinations of risk and return obtainable by combining the market portfolio with borrowing or lending. The CAPM suggests a required rate of return that is made up of two separate components:

i. The CAPM's intercept R represents the point of time. This component of the nth assets requiredrate of return compensates the investor for delaying consumption in order to invest.

ii. The slope of the CAPM, $E(r_m)$ - R, the second component is the market price of the risk. The market price of risk is multiplying by nth assets systematic risk coefficient. The product of this multiplication determines the appropriate risk premium i.e. additional return. That should be

added to the risk less rate to find the asset's required rate of return. This risk premium induces investors to take risk.

13.5 CAPITAL MARKET LINE (CML)

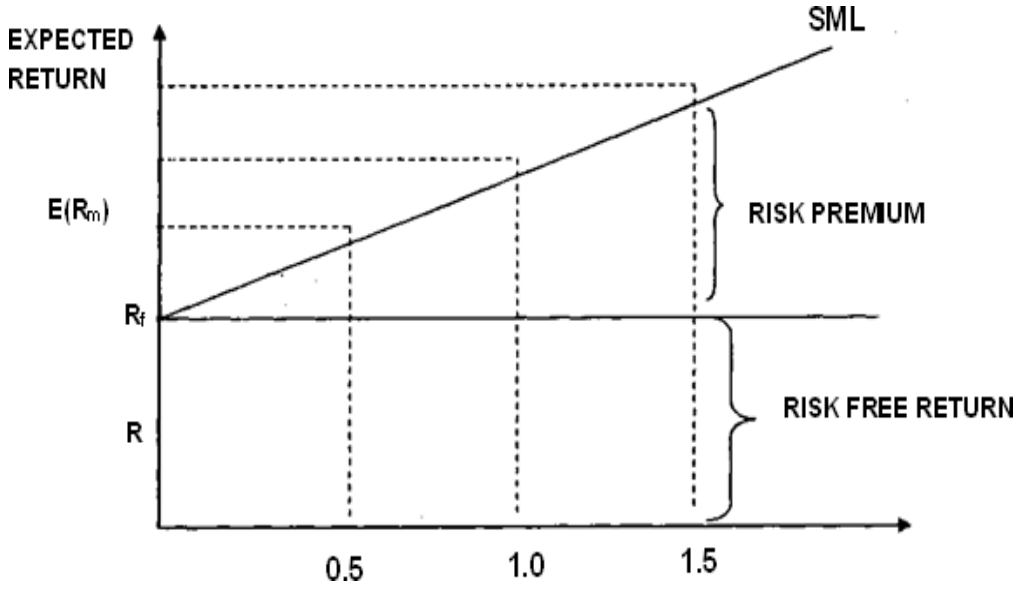
The capital market line (CML) defines the relationship between total risk and expected return forportfolios consisting of the risk free asset and the market portfolio. If all the investors hold the same risky portfolio, then the equilibrium it must be the market portfolio. CML generates

a line on which efficient portfolios can lie. Those which are not efficient will however lie below the line. 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 statistics should lie on the CAPM but below the CML. In contrast the risk less end (R) statistics ofall portfolios, even the inefficient ones should plot on the CAPM. The CML will never include all points, if 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 includes diversifiable risk.

13.6 SECURITY MARKET LINE (SML)

Security market line describes the expected return of all assets and portfolios of assets in the economy. As discussed earlier, the risk of any stock can be divided into systematic risk and unsystematic risk. Beta (b) is the index of systematic risks. In case of portfolios involving complete diversification, where the unsystematic risk tends to zero, there is only systematic risk measured by beta. Thus, the dimensions of the security which concern us are expected return and beta. The expected return on any asset or portfolio, whether it is efficient or not can be determined by SML by focusing on beta of securities. The higher the beta for any security the higher must be its equilibriumreturn.

Further the relationship between beta and expected return is linear. The SML expresses the basic theme of the CAPM i.e. expected rate of return increases linearly with risk, as measured by beta. It can be drawn as follows:



Security Market Line

The SML is an upward sloping straight line with an intercept at the risk free return securities andpasses through the market portfolio. The upward slope of the line indicates that greater expected returns accompany higher levels of Beta. In equilibrium each security or portfolio lies on the SML.

The above figure shows that the return expected from portfolio or investment is a combinationof risk free return plus risk premium. An investor will come forward to take risk only if the return on investment also includes risk premium.

Thus the expected return on a portfolio E(RJ consists of the following: R_f = risk free premium (i)

$R_m - R_f$ = risk premium (ii)

R_m = expected total return (1 + 2)

The CAPM has shown the risk and return relationship of a portfolio in the following formula: $E(R1) = Rf+B1(Rm-Rf)$

Where $E(R_t)$ = expected rate of return on any individual security or portfolio of securities. R_f = Risk free rate of return

R_m = Expected rate of return on market portfolio

B, = Market sensitivity index of individual security or portfolio of securities.

Illustration

Sunrise holding Ltd. An investment company has invested in equity shares of a blue chip company. Its Risk free return (R_f) = 9%

Expected total return (R_m) =16%

Market sensitivity index (B.) = .8%

Calculate the expected rate of return on the investment made in the security.

Solution $E(R,) = R_f + B,(R_m - R,)$

$= 9 + 0.8(16-9)$

$= 9 + 0.8(7)$

= 9 + 5.6 =

14.6%

SML validates the claim that systematic risk is the only important ingredient in determining expected returns and that non-systematic risk plays no role. In other words, the investor gets rewarded for bearing systematic risk. It is not total variance of returns that affects expected returns but only that part of variance in return that cannot be diversified away. If investors can eliminate all non-systematic risk through diversification, there is no reason they should not be rewarded in terms of higher return for bearing it.

13.7 THE ASSET PRICING IMPLICATIONS OF CAPM

i. The CAPM has asset pricing implications because it sells what required rate of return should be used to find the present value of an asset with any particular level of systematic risk (beta). In equilibrium, every asset's expected return and systematic risk coefficient should plot as onepoint on the CAPM. If the assets expected rate of return is different from its required rate of return, that asset is either underpriced or overpriced. This implication is useful only if the beta coefficients are stable overtime. However, in reality, the betas of assets do change with the passage of time as the assets earning power changes. The job of security analyst is, thus, tofind the assets with dis-equilibrium prices, because it will be profitable to buy underpriced assetsand sell short the overpriced assets.

ii. With the help of CAPM, every investor can analyze the securities and determine the composition of his portfolio. Since, there is a complete agreement among investors on the estimates of expected return, variance and covariance and risk free rate, efficient set of portfolioshould be the same for all the investors. Since all the investors face the same efficient set, the only reason they choose different portfolios curve is the locus of all possible portfolios that provide the investor with the same level of expected utility. Expected utility will increase as one moves from lower indifference curve, any point on the curve gives the same utility. Such curves are positively sloped and convex for risk averters, concave for risk seekers and horizontal forrisk neutral investors.

Thus, different investors will choose different preference towards risk and return. It implies that each investor will spread his funds, among risky securities in the same relative proportion adding risk free borrowing or lending in order to achieve a personally

preference overall combination of risk and return. This feature of CAPM is often referred to as separation theorem,

iii. Another important' implication is that no security can in equilibrium have a tangency to touch, either axis on risk return space. If an investor has zero proportion in such securities, the pricesof these would eventually fall, thereby causing the expected returns of these securities to rise until the resulting tangency portfolio has a non-zero proportion associated with it. Ultimately everything will be balanced out. When all the price adjustments stop, the market will be brought into equilibrium, subject to the following conditions:

a) Each investor will like to hold a certain positive amount of each risky security.

b) The current market price of each security will be fixed at a level where the number of sharesdemanded equals the number of shares outstanding.

c) The risk free rate will be fixed at a level where the total amount of borrowings will be equal tothe total amount of money lent.

As a result, in equilibrium the proportion of the tangency portfolio will correspond to the proportion of the market portfolio. The market portfolio is a portfolio consisting of all the securities where the proportion invested in each security corresponds to its relative market value.

Where the,

$$\text{Relative market} = \frac{\text{aggregate market value of the security}}{\text{sum of aggregate market values of all the securities}}$$

Value of security

The market portfolio plays a very important role in the CAPM because efficient set consists of an investment in the market portfolio coupled with a desired amount of either free borrowing or lending. Tangency portfolio is commonly referred to as the market portfolio.

(v) For any individual investor, security prices and returns are fixed, whereas the quantities held can be altered. For the market as a whole, however, these quantities are fixed (at least in the short run) and prices are variable. As in any competitive market, equilibrium requires the

adjustment of each security's price till there is consistency between the quantity desired and quantity variable. Therefore, is but reasonable and logical that historical returns on securities should be examined to determine whether or not securities should be examined to determine whether or not securities have been priced in equilibrium as suggested by the CAPM.

13.8 LIMITATIONS OF CAPM:

Though the CAPM has been regarded as a useful tool for both analyst of financial securities andfinancial managers, it is not without critics. The CAPM has serious limitations in the real world,discussed as follows:

1. The CAPM is based on expectations about the future. Expectations cannot be absorbed but we do have actual returns. Hence empirical tests and data for practical use tend to be based almostexclusively on historical returns.
2. Beta (systematic risk) coefficient is unstable, varying from period to period depending up on the method of complication. They may not be reflective of true risk involved. Due to the unstable nature of beta it may not reflect the future volatility of returns although it is based on the post history. Historical evidence of the tests of beta showed that they are unstable and they are not positively related to future risk.
3. CAPM focuses attention only on systematic (market related) risk. However, total risk has been found to be more relevant and both types of risk appear to be positively related to returns.
4. Investors do not seen to follow the postulation of CAPM and do not diversify in a planned manner.
5. The analysis of SML is not applicable to the bond analysis, although bonds are a part of the portfolio of the investors. The factors influencing bonds in respect of risk and return are different and the risk of bonds is rated and known to investors.

Thus, it can said that the applicability of CAPM is broken by the less practical nature of this model as well as complexity and difficulty of dealing with beta values.

13.9 RISK FREE RATE OF LENDING OR BORROWING

The three factors discussed in CAPM are systematic risk (B), the expected market return

and the risk free rate. The risk free rate is the least discussed of the three factors. It is used only twice in CAPM. It is first used as a minimum rate of return ® and it is used to find out the risk premium (rm -R). Thus, any error in estimating the risk free rate of return would lead to a wrong estimate of the expected rate of return for an asset or portfolio. Choosing a wrong risk free rate would mean that the analyst would misunderstand the sources of the asset's returns, the quality of its performance or have poor data on which to make forecasts.

In CAPM theory, the risk free asset is one of the two choices available to the investor. The investor can reduce the risk of the portfolio by increasing the amount of risk free asset in the portfolio orhe can increase the risk by reducing the risk free asset position or by borrowing at the risk free rate to further invest. In fact, the risk free rate is the rate that will entice investors to choose between current orfuture consumption between savings or investment. The price required to induce an investor to forgo current consumption for a certain future sum, to forgo liquidity, is the price of time or the risk free rate ofreturn.

The separation theorem propounded by James Tobin States that the investors make portfolio choices solely on the basis of risk and return, separating that decision from all other factors, the CAPM is incomplete because it ignores other relevant factors. Thus, it is implied that each investor will spread his funds among risky securities in the same relative proportion, adding risk free borrowing or lending inorder to achieve a personally preferred overall combination of risk and return. Risky portion of every investor's portfolio is independent of the investor's risk return preference. The justification for this is thatthe risky portion of each investor's portfolio is simply beyond the either axis. Even if the investor commits zero proportion in these securities, the prices of these would eventually fall, thereby causing the expected returns of these securities to rise until the resulting tangency portfolio has a non-zero proportion associated with it. Ultimately, everything will be balanced out. When all the price adjusting stops the market will be brought into equilibrium.

13.10 ARBITRAGE PRICING MODEL

Like the CAPM, the arbitrate pricing model is an equilibrium model of asset pricing but its originsare significantly different. Whereas the CAPM is a single factor model, the APM is a multi-factor model. Instead of just a single beta value, there is a. whole set of beta values-one for each factor. Arbitrate pricing theory out of which APM arises states that the expected return on investment is dependent uponhow that investment reacts to a set of individual macro-economic

factors (the degree of reaction being measured by the beta) and the risk premium associated with each of those macroeconomic factors. The APM was developed in 1976 by Ross. This model does not depend critically on the notion of an underlying market portfolio. Instead, it is model that derives returns from the properties of the process generating stock returns and employs arbitrate pricing theory to define equilibrium. Under certain circumstances it derives a risk return relationship identical to the SML of the CAPM. The arbitrate theory is based on the following assumptions:

i. The investors have homogeneous beliefs/expectations

ii. The investors are risk avert utility maximisers

iii. The markets are perfect so that factors like transaction costs are not relevant

iv. The security returns are generated according to a factor model

v. Risk returns analysis is not the basis. The model takes the view that there are underlying factors that give rise to returns on stocks. Examples of these factors might include such variables as real economic growth and inflation or such financial variables as dividend yield and capital structure. The objective of security analysis is to identifythese factors in the economy and the sensitivities of security return to movements in these factors. A formal statement of such a relationship is termed as a factor model of security returns.

9.4.(1) SINGLE FACTOR MODEL

According to this model the asset depends on a single factor, say Gross National Product or industrial production on interest rates, money supply, interest rates and so on. In general, a singlefactor model can be represented in equation from as follows:

R = E + bf + e

Where E = uncertain return on security I

b = security's sensitivity to change in the factor

f = the actual return on the factor e = error term (unexplained variable)

Thus, this model only states that the actual return on a security equals the expected return plus sensitivity times factor movement plus residual risk.

9.4.(2) MULTIPLE FACTOR MODEL

Work suggests that a number of variables should be taken into account for asset pricing. The above mentioned equation can, thus be expanded to:

$$R=E + b_1f_1 + b_2f_2 + b_3f_3 + \quad + e$$

Each of the middle terms in the equation is the product of returns on a particular economic factor and the given stock's sensitivity to that factor.

But the basic question is what three factors are? They are the underlying economic forces that are 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, individual 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 differentperceived risk of default.)
- Changes in the inflation rate
- Changes in the interest rate
- The level of personal consumption
- The level of money supply in the economy

9.4.(3) DERIVING THE ARBITRAGE PRICING THEORY

With the help of APM, investment strategies of many types can be selected if there are many securities to be selected and a fixed amount to be invested the investor can choose in a manner that hecan aim at zero nonfactor risk. This is possible by combining securities to hedge out the sensitivity of a portfolio to all but one factor.

APT says nothing about either the magnitude or the rings of the facto coefficients or what the factors themselves might be. The model does not give us this guidance nor did Ross when he first found this model. The theory does not say anything about how the identify and magnitude of the factorsshould be determined. It says that by active trading of securities with different sensitivities to the important factors. Investors trade away opportunities for excessive gains.

Since there are only a few systematic factors affecting returns, many portfolios are close substitutes for each other and thus will have the same value. Excessive gains come only when, by buying some assets and selling others the investor hedges his portfolio and thereby insulates it from risk without eliminating excess return. These excessive gains are called arbitrate profits. In efficient markets, excess returns are eliminated by trading and investors cannot on average or over time, find opportunities to arbitrate for profits.

A simple example will demonstrate what arbitrate profit is and how an investor can take advantage of it, if it were available. Let us assume a market where there are only three assets, all sensitive to only one factor e.g. changes in the real interest rate. The sensitivities of each of the assets to the common factor, real interest rate and the expected returns are shown in the following table:

Asset	**Factor Sensitivity**	**Expected Returns**
A	0.0	8%
B	0.5	12%
C	1.5	15.5%

It can be seen that asset B is expected to have a return of 12%. Since the return that would usually be expected for an asset with sensitivity to interest rate is 10.5%, asset B promises an excess return of 1.5%. To take advantage of this excess return and to do so with no risk, an investor can arbitrate among three assets, the investor with Rs.2000 need only buy Rs.1000 of asset B and short sell Rs.667 of risk free security A and Rs.333 of security c. the results of buying and short selling activities are shown in the following table:

Amount	**Asset**	**Expected Return**	**Factor Sensitivity**
Buy: Rs. 1000	B	12%	0.5
Short sell-Rs.667	A	(5.4%)*	0.0
Rs. 333	C	(5.11)**	(0.5)***

		(10.5%)	(0.5)
Portfolio: Rs.2000		1.5%	0.0

.67x8% **.33x15.5% ***.33x1.5

The investor earns 1.5% excess return and does so without risk, the factor sensitivity of asset B is offset by the average sensitivity of the short sold portfolio, and inequities offer opportunities to arbitrate.

The same situation exists when assets are priced on more than one factor. APT allows for as many factors as are important in the pricing of the assets. The Apt thus describes of most investors, who are opportunity seekers and believe that opportunities to make profits exist. Such investors however dislike higher levels of risk. The fact is that there is always a trade-off between risk and return, which is not considered by the APT model. Therefore, in practical portfolio operations, it is better to combine the capital asset pricing theory and the APT model.

9.4.(4) PRACTICAL APPLICATIONS OF APT

Since the introduction of APT by Ross, it has been empirically discussed, evaluated and tested:

(i) An initial test of APT was conducted by Roll and Ross. They used a statical technique called factor analysis. The input to factor analysis is the covariance matrix among the returns to the securities in the sample. Factor analysis determines the set of factor beta that best explains the covariance among the securities in the sample. Because of its complex nature, the factor analysis can be employed on relatively small samples of firms. Conducting the tests on small samples they can be diversified away and they will not be priced. As such they are of no interestIH testing the theory.

(ii) Dhyrymes, friend and Gultekin, found that as the number of securities in the factor analysis increase say from fifteen to sixty, the number of significant factors increases from three to seven. In a later paper they found that the number of priced factors increases with the numberof securities factor analysis. These initial empirical results indicate that the APT may be difficult to test by factor analysis.

(iii) Chen, Roll and Ross found that as an alternative to using factor analysis. Investor can

hypothesis that a given set of specified factors explain the covariance matrix among securities. In this approach, the investor can use large samples to estimate the factor betas and the factor prices. They determined that a large fraction of the covariances among securities can be explained on the basis of unanticipated changes in four specified factors:

- The difference between the yield on a long term and short term risk free security.
- The rate of inflation.
- The growth rate in industrial production
- The difference between yields of high rated securities and risk free securities.

(iv) Shanken argued that the shares of stock traded in the market place are actually portfolios of theindividual units of production in the economy. Given a factor structure that explains the covariance among the returns to individual units of production, we may not be able to recognize it on the basis of the portfolio.

Thus, the investors are in a position on similar to the one they were in with the CAPM. In the CAPM, even the best assets are only a small fraction of the true market portfolio. With the Apt, even if the investor increases the size of the sample; his sample is only a small fraction of the total number of production units in the international economic system. The APT also does not tell the number of factors,the investor should expect to see or the names for any of the factors. Consequently, the number of factors priced by the market is greater than the number he estimated. Investors may, however, feel more comfortable if he finds that the number of priced factors increases at a decreasing rate as the sample size increases.

13.11 SELF CHECK EXERCISE

1. Explain Capital Market Theory.
2. Explain Security Market Line.
3. Discuss the asset pricing implication of CAPM.
4. Explain Arbitrage Pricing Model.

13.12 SUMMARY

William F. Sharpe and John Linter developed the Capital Asset Pricing Model (CAPM). The model is based on the portfolio theory developed by Harry Markowitz. The model

emphasizes the risk factor in portfolio theory is a combination of two risks, systematic risk and unsystematic risk. The model

suggests that a security's return is directly related to its systematic risk, which cannot be neutralized through diversification. The combination of both types of risks stated above provides the total risk. The total variance of returns is equal to market related variance plus company's specific variance. 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. CAPM 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 analyzing 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.

13.13 GLOSSARY

Beta: The measure of asset sensitivity to a movement in the overall market.

CAPM: A model that explains relative security prices in terms of a security's contribution to the risk ofthe whole portfolio, not its individual standard deviation.

Security Characteristic Line (SCL): It represents the relationship between the market return (r_m) andthe return of a given asset i (r_i) at a given time t.

Arbitrage: The practice of taking advantage of a state of imbalance between two (or possibly more)markets and thereby making a risk-free profit, Rational Pricing.

13.14 ANSWERS TO SELF CHECK EXERCISE

1. For answer refer to section 13.5
2. For answer refer to section 13.6
3. For answer refer to section 13.7
4. For answer refer to section 13.10

13.15 TERMINAL QUESTIONS

1. .Explain capital market theory. What are its assumptions?

2. Discuss Capital asset Pricing Model. What are its limitations?

13.16 SUGGESTED READINGS

- Samuels J. M, F.M. Wilkesard R.E. Brayshaw, Management of Company Finance, Chapmanand Flail, London
- Smith, Edger Lawrence, Common Stocks as Long-term Investment, New York, MacMillan.
- Sprinkel, Beryl, W., Money and Stock Prices, Homewood III, Richard S. Irwin, Inc.
- Sudhindhra Bhatt, Security Analysis and Portfolio Management, Excel Books.
- Fischer, D.E., Security Analysis and Portfolio Management, Prentice Hall, 1983.
- Reilly, F.K., Investment Analysis & Portfolio Management, Drygen Press, 1985.

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CHAPTER-14

ARBITRAGE PRICING THEORY

Structure:-

14.0 LEARNING OBJECTIVES

After reading this chapter, you will be able to:-

- Discuss in detail the arbitrate pricing theory
- Describe some the problem associated with the empirical testing of APT

14.1 INTRODUCTION

Arbitrage Pricing Theory (APT) in finance is a general theory of asset pricing, which has become influential in the pricing of shares. APT holds that the expected return of a financial asset can be modeled as a linear function of various macro-economic factors or theoretical market indices, where sensitivity to changes in each factor is represented by a factor specific beta coefficient. The model- derived rate of return will then be used to price the asset correctly - the asset price should equal the expected end-of period- price discounted at the rate implied by

model. If the price diverges, arbitrage should bring it back into line. The theory was initiated by the economist Stephen Ross in 1976.

14.2 ARBITRAGE PRICING THEORY

The, CAPM and Its extensions are based on Specific assumptions on investors asset demand i.e.

Investor care only about mean return and varianceInvestor hold only traded assets

The CAPM has several weaknesses which the APT attempts to overcome.

The Arbitrage Pricing theory starts with specific assumptions on the distribution of asset returns and relies on approximate arbitrage argument.

In particular, APT assumed a "factor model" of asset returns.

14.3 ASSUMPTIONS OF APT:

Returns are generated according to a linear factor model.The numbers of assets are close to infinite.

Investor has homogeneous expectations

Capital markets are perfect (i.e. no transaction cost).

14.4 ARBITRAGE IN ECONOMICS AND FINANCE

In Economics and Finance Arbitrate is the practice of taking advantages of price differential between two or more market: combinations of matching deals are struck that capitalize upon the imbalance, the profit being the difference between the market prices. When used by academics, an arbitrage is a transaction that involves no negative cash flow at any probabilistic or temporal state and apositive cash flow in at least on state; in simple terms, a risk free profit.

A person who engages in arbitrage is called an arbitrageur, the term is mainly applied to trading in financial instruments, such as bonds, stocks, derivatives, commodities and currencies.

If the market prices do not allow for profitable arbitrate, the prices are said to constitute an arbitrate equilibrium or arbitrate free market. An arbitrate is equilibrium is a precondition for a general economic equilibrium.

Statistical arbitrate is an imbalance in expected values. A casino has a statistical arbitrate

in almost every game of chance that it offers.

14.5 CONDITIONS FOR ARBITRAGE

Arbitrage is possible when one of the three conditions is met:

1. The same asset does not trade at the same price on all markets. ("The law of one Price")
2. Two assets with identical cash flows do not trade at the same price.
3. An asset with a known price in the future does not today trade at its future price' discounted at the risk free interest rate (or, the asset does not have negligible costs of storage; as such for example, this condition holds for grain but not for securities.

Examples:

In the most simple example, any good sold in one market should sell for the same price in another. Traders may, for example, find out that the price of wheat is lower in agricultural regions thanin cities, purchase the good and it cities, purchase the good, and transport it to another region to sell at the higher price. This type of price arbitrate is the most common; but this simple example ignores the cost of transport, storage, risk and other factors. "True" arbitrate requires that there be no risk involved where securities are traded on more than one exchange, arbitrate occurs by simultaneously buying in one and selling on the other.

Economics use the term "global labor arbitrate" to refer to the tendency of manufacturing jobs toflow towards whichever country has the lowest wages per unit output at present and has reached the minimum requisite level of political and economic development to support industrialization. At present many such jobs appears to be flowing towards china, though some which require English are coming toIndia.

High demand limited goods such as an event ticket as video game console. The market price is fixed secondary deals such as online auctions will often fetch consistently higher price. Then can involve almost no risk at all under the right circumstances, but requires an, investment of time toactually acquire the in demand good to sell.

14.6 SELF CHECK EXERCISE

1. Discuss the assumptions of Arbitrage pricing theory.
2. What are conditions for arbitrage?

3. Discuss APT asset pricing line.

14.7 SUMMARY

The Arbitrage Pricing Model (APM) looks very similar to the CAPM, but its origins are significantly different. Whereas the CAPM is a single-factor model, the APM is a multi-factor model instead of just a single beta value; there is a whole set of beta values - one for each factor. Arbitrage Pricing Theory, out of which the APM arises, states that the expected return on an investment is dependent upon how that investment reacts to a set of individual macro-economic factors (the degreeof reaction being measured by the betas) and the risk premium associated with each of those macro- economic factors. The APT differs from the CAPM in that it is less restrictive in its assumptions.

14.8 GLOSSARY

Beta: The measure of asset sensitivity to a movement in the overall market.

CAPM: A model that explains relative security prices in terms of a security's contribution to the risk ofthe whole portfolio, not its individual standard deviation.

Security Characteristic Line (SCL): It represents the relationship between the market return (r_m) andthe return of a given asset i (r_i) at a given time t.

Arbitrage: The practice of taking advantage of a state of imbalance between two (or possibly more)markets and thereby making a risk-free profit, Rational Pricing.

14.9 ANSWERS TO SELF CHECK EXERCISE

1. For answer refer to section 14.3
2. For answer refer to section 14.5
3. For answer refer to section 14.6

14.10 TERMINAL QUESTIONS

1. Critically evaluate Arbitrage Pricing Model.
2. As an investor, how do you use the APT?
3. What do you see as the difference between arbitrage and the APT?

14.11 SUGGESTED READINGS

- Samuels J. M, F.M. Wilkesard R.E. Brayshaw, Management of Company Finance, Chapmanand Hall, London
- Smith, Edger Lawrence, Common Stocks as Long-term Investment, New York, MacMillan.
- Sprinkel, Beryl, W., Money and Stock Prices, Homewood III, Richard S. Irwin, Inc.
- Sudhindhra Bhatt, Security Analysis and Portfolio Management, Excel Books.
- Fischer, D.E., Security Analysis and Portfolio Management, Prentice Hall, 1983.
- Reilly, F.K., Investment Analysis & Portfolio Management, Drygen Press, 1985.

CHAPTER-15

FACTOR MODEL

15.0 LEARNING OBJECTIVES

After reading this chapter, you will be able to:-

- Describe the Factor Model and its types
- Discuss the uses and importance of factor model
- Discuss the advantages and disadvantages of factor model

15.1 INTRODUCTION

This analysis technique helps investors diversify portfolio based on the profits and losses depicted. Factor models intricately combine macroeconomic, fundamental, and statistical

factors to establish market equilibrium and ascertain requisite rates of return. By tethering a security's returns to one or more risk factors within a linear framework, these models offer an alternative avenue to the Modern Portfolio Theory for investment analysis. The realm of factor models is categorized into two principal variants: single-factor and multiple-factor models. These frameworks elucidate the interplay of factors affecting asset returns, enabling a deeper understanding of investment dynamics. Factor models, as the name suggests, are techniques that help assess the risks and returns that a security or financial instrument is supposed to generate or derive. These models take into consideration the factors that commonly influence the financial instruments as well as factors that specifically influence to those instruments only. Based on the types of factors these models consider, they can be explicit and implicit in nature. The explicit class is the one which depends on the predetermined determinants, which are independent of the data or instrument involved. Such factors are based on the established theories and include determinants, like inflation, economic growth, etc.

15.2 FACTOR MODELS

Factor Models refers to the study and assessment of financial models factors (macroeconomic, fundamental, and statistical) to determine the market equilibrium and calculate the required rate of return. Such models associate the return of a security to single or multiple risk factors in a linear model and can be used as alternatives to Modern Portfolio Theory. Factor models allow entities to study the risk and return associated with a security. The factors that are studied can be basic, technical, macroeconomic, etc. This analysis technique helps investors diversify portfolio based on the profits and losses depicted. Factor models intricately combine macroeconomic, fundamental, and statistical factors to establish market equilibrium and ascertain requisite rates of return. By tethering a security's returns to one or more risk factors within a linear framework, these models offer an alternative avenue to the Modern Portfolio Theory for investment analysis. The realm of factor models is categorized into two principal variants: single-factor and multiple-factor models. These frameworks elucidate the interplay of factors affecting asset returns, enabling a deeper understanding of investment dynamics. Factor models, as the name suggests, are techniques that help assess the risks and returns that a security or financial instrument is supposed to generate or derive. These models take into consideration the factors that commonly influence the financial instruments as well as factors

that specifically influence to those instruments only. Based on the types of factors these models consider, they can be explicit and implicit in nature. The explicit class is the one which depends on the predetermined determinants, which are independent of the data or instrument involved. Such factors are based on the established theories and include determinants, like inflation, economic growth, etc.

On the contrary, the implicit class indicates the model type that depends on the internal input only. Some examples of implicit class of models include factor analysis, component analysis. These analyses not only help derive factors, but also factor exposures. These models serve multiple purposes, which make these models one of the most significant risk and reward assessment techniques. Below are some of the functions related to factor models:

- Maximization of the excess return, i.e., Alpha (α) of the portfolio;
- Minimization of the volatility of the portfolio, i.e., the Beta (β) of the portfolio;
- Ensure sufficient diversification to cancel out the firm-specific risk.

In short, factor models help investors understand the opportunities, potential, and risks associated with the financial instruments they are willing to invest in. Based on the analysis and assessment of the risk and returns that a security offers, the investors make smarter and wiser investment decisions.Researchers developed factor models to approximate the returns of financial securities or transactions by applying various statistical techniques to factors influencing the compared return. Therefore, the models are so-called because the outcome depends on the factors included. The weight assigned to each factor depends on how much it affects the return or the dependent variable, considering factors such as government rules and regulations, seasonality, market environment, etc. There can be various types of models depending on the depth of the analysis. Therefore, they are broadly classified into two heads, which are single and multi-factor models. Regression is a popular method for using simpler or more complicated statistics.

15.3 TYPES OF FACTOR MODEL

As described above, there can be two broad heads of these models, Single Factor Models and Multi-Factor Models. The equations of each are as follows:

15.3.1 Single Factor Model

This model involves using only one independent variable to approximate the dependent variable and has an equation of the following form:

$y = \alpha + \beta 1X1 + \in 1$

Here y is the dependent variable, = the intercept variable, = the slope variable, = the independent variable or the factor, = error term

CAPM equation is an example of the single factor model wherein the equation is as follows:

$E(r) = Rf + \beta 1(Rm - Rf)$

Here we approximate the expected return on the basis of risk-free return and the market risk premium. At the same time, beta is the slope coefficient, and risk-free return is the intercept coefficient.

The intercept coefficient implies the value of the dependent variable when the factor value = 0

The slope coefficient determines the rate of change in the dependent variable to the rate of change in the independent variable.

15.3.2 Multiple Factor Model

A multi-factor model is a financial model that employs multiple factors in its calculations to explain market phenomena and/or equilibrium asset prices. A multi-factor model can be used to explain either an individual security or a portfolio of securities. It does so by comparing two or more factors to analyze relationships between variables and the resulting performance.

Multi-factor models are used to construct portfolios with certain characteristics, such as risk, or to track indexes. When constructing a multi-factor model, it is difficult to decide how many and which factors to include. Also, models are judged on historical numbers, which might not accurately predict future values.

Multi-factor models also help explain the weight of the different factors used in the models,

indicating which factor has more of an impact on the price of an asset.

Multi-Factor Model Formula

Factors are compared using the following formula:

Ri = ai + _i(m) * Rm + _i(1) * F1 + _i(2) * F2 +...+_i(N) * FN + ei

Where:

Ri is the return of security

Rm is the market return

F(1, 2, 3 ... N) is each of the factors used

_ is the beta with respect to each factor including the market (m)

e is the error term

a is the intercept

Types of Multi-Factor Models

Multi-factor models can be divided into three categories: macroeconomic models, fundamental models, and statistical models.

- **Macroeconomic models:** Macroeconomic models compare a security's return to such factors as employment, inflation, and interest.
- **Fundamental models:** Fundamental models analyze the relationship between a security's return and its underlying financials, such as earnings, market capitalization, and debt levels.
- **Statistical models:** Statistical models are used to compare the returns of different securities based on the statistical performance of each security in and of itself. Many times, historical data is used in this type of modeling.

Construction of Multi-Factor Models

- The three most commonly used models to construct a multi-factor model are a combination

model, a sequential model, and an intersectional model.

- **Combination model:** In a combination model, multiple single-factor models, which utilize a single factor to distinguish stocks, are combined to create a multi-factor model. For example, stocks may be sorted based on momentum alone in the first pass. Subsequent passes will use other factors, such as volatility, to classify them.
- **Sequential model:** A sequential model sorts stocks based on a single factor in a sequential manner to create a multi-factor model. For example, stocks for a specific market capitalization may be sequentially analyzed for various factors, such as value and momentum, sequentially.
- **Intersectional model:** In the intersectional model, stocks are sorted based on their intersections for factors. For example, stocks may be sorted and classified based on intersections in value and momentum.

Measurement of Beta

- The beta of a security measures the systematic risk of a security in relation to the overall market. A beta of 1 indicates that the security theoretically experiences the same degree of volatility as the market and moves in tandem with the market.
- A beta greater than 1 indicates the security is theoretically more volatile than the market. Conversely, a beta less than 1 indicates the security is theoretically less volatile than the market.
- When multi-factor models are used by investment managers to assess the risk of investments, beta is an important factor that they can use.

15.4 USES AND IMPORTANCE OF FACTOR MODEL

- The Finance industry presently utilizes many different models, while organizations can develop new models for specific industries or any other purpose.
- These applications extend beyond Finance and encompass various disciplines such as

science, economics, sociology, anthropology, etc.

- Investors use factor models developed by many indices to predict their returns, aiding them in investing decisions.
- These models are also used in identifying the most appropriate capital structure for a company because the WACC formula is also a multi-factor model that considers the costs and weights of capital sources and therefore helps calculate the cost of capital for different capital structures.
- Analysts use such models to identify the causes of a given return in the performance attribution of portfolios. Thus, the skill and performance of the portfolio manager are also quantified, based on which her remuneration number is generated.

15.5 ADVANTAGES OF FACTOR MODEL

- Factor models help pinpoint the cause of the change in the dependent variables and identify the factors causing the same. Once the cause-and-effect relationship is clearly defined, it is easier to harness and predict such impacts in a structured manner.
- Investing can be scientific and higher returns can achieve using models with high predictive power. Therefore, algorithms can generate automated trading. However, such automation is only used when the stakes are not very high because this limits the losses, which might be huge otherwise.
- Businesses can develop marketing and expansion strategies based on factor models of their domain and thereby develop a plan to achieve higher profits and then closely monitor the results. This helps them align the company's goals and objectives as a whole.

15.6 DISADVANTAGES OF FACTOR MODEL

- Identifying the right factors is not an easy task, and many cautions need to be considered to draw a valid conclusion out of a given model. If the data set is affected by multicollinearity or serial correlations and other violation of regression assumptions, then the model can become unstable and not have any consistent predictive power.

- Factor models are not highly cost-effective. They require sophisticated statistical techniques, which in turn require expensive technology and, therefore, cannot be used by smaller companies or retail investors who don't possess the necessary resources.
- These models require highly skilled human capital because these require advanced mathematical acumen; therefore, the people involved in such research come at a high cost.
- At times adding more factors might not explain the effect on the dependent variable, and therefore, the model might reach a particular limit and that might not be too extensive to justify the time, money, and effort that goes into such analysis.

15.6 SELF CHECK EXERCISE

1. What do you mean by factor model?

2. Discuss the uses and importance of factor model.

3. Explain the types of factor model.

15.7 SUMMARY

Factor models intricately combine macroeconomic, fundamental, and statistical factors to establish market equilibrium and ascertain requisite rates of return. By tethering a security's returns to one or more risk factors within a linear framework, these models offer an alternative avenue to the Modern Portfolio Theory for investment analysis. The realm of factor models is categorized into two principal variants: single-factor and multiple-factor models. These frameworks elucidate the interplay of factors affecting asset returns, enabling a deeper understanding of investment dynamics. Factor models, as the name suggests, are techniques that help assess the risks and returns that a security or financial instrument is supposed to generate or derive. These models take into consideration the factors that commonly influence the financial instruments as well as factors that specifically influence to those instruments only. Based on the types of factors these models consider, they can be explicit and implicit in nature.
GLOSSARY

15.8 ANSWERS TO SELF CHECK EXERCISE

1. For answer refer to section 15.2
2. For answer refer to section 15.4
3. For answer refer to section 15.3

15.9 TERMINAL QUESTIONS

1. Define factor model. Explain its types.

2. Discuss the uses and importance of factor model.

15.10 SUGGESTED READINGS

- Samuels J. M, F.M. Wilkesard R.E. Brayshaw, Management of Company Finance, Chapmanand Hall, London
- Smith, Edger Lawrence, Common Stocks as Long-term Investment, New York, MacMillan.
- Sprinkel, Beryl, W., Money and Stock Prices, Homewood III, Richard S. Irwin, Inc.
- Sudhindhra Bhatt, Security Analysis and Portfolio Management, Excel Books.
- Fischer, D.E., Security Analysis and Portfolio Management, Prentice Hall, 1983.
- Reilly, F.K., Investment Analysis & Portfolio Management, Drygen Press, 1985.

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