CHAPTER 1

INTRODUCTION

INTRODUCTION

Financial economics is a branch of economics that assesses the use and distribution of economic resources in an uncertain environment, both regionally and over time. It is essentially based on microeconomics and decision theory which analyses how a rational investor would apply decision theory to decide on an investment in such times. Trade, in terms of economic activity, is in the form of money that is exchanged/traded for an item/s. However, in financial economics trade is based on monetary activities where money in one form or another appears on both sides of the trade. The decision to trade for money in the current period for the future is a fundamental concept that falls in its domain; whereas, risk is the crucial element of financial decision making.

1.1 RISK

In its most basic form, a risk is the result of a decision made in a certain situation that may result in either loss or gain. It is defined as likelihood or loss that is caused by internal or external forces which can be reduced by taking preventive steps. The definition of risk in financial terms is that it denotes a degree of uncertainty about the expected returns on investment, implying that the probability of actual returns may differ from the expected returns. Although, the most appropriate definition of risk was given by Knight (1921, p.233), " To preserve distinction between measurable uncertainty and an unmeasurable one, we may use the term "risk" to designate the former and the term "uncertainty" for the latter" (p.233). Harry Markowitz's portfolio theory (1952, p.77) explains how investors might optimize risk and return when constructing investment portfolios. It's worth noting that "Portfolio Selection" paper written by Harry Markowitz has no definition of risk. The regulation he presented was as follows:

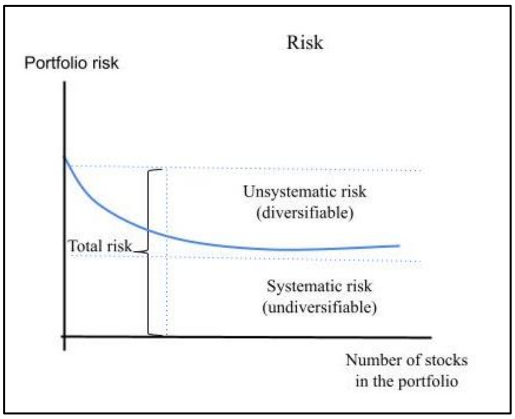
....that the investor does (or should) consider expected return a desirable thing and variance of return an undesirable thing (p.77).

Any investor makes his investment decision based on the expected return on investment. It is quite possible that the investment's real return will differ from what was projected. As a matter of fact, risk is the likelihood that the actual return will differ from the predicted return. If the realised and predicted returns are equal, there is no risk. When it comes to investments, risk develops when there is a possibility of differing expectations from actual results. This variation in an investment's returns is the essence of risk and is caused by a variety of factors. The elements of risk are the factors that cause variations in the returns on an investment.

The elements of risk can be divided into two categories.

1. Systematic Risk – (e.g., Interest rate risk, inflation risk, market risk)
2. Unsystematic Risk – (e.g., Business risk, financial risk)

Figure 1.2: Total Risk



Source: Modern portfolio theory – Francis & Kim

The total risk of an investment is represented by its total return variability. It is made up of two parts: systematic risk and unsystematic risk.

In simple terms risk can also be referred as "dispersion of the data around the expected value". In common parlance, however, the term dispersion of the data is a less prevalent term. Normally, variance and standard deviation are mathematical expressions that represent the spread (dispersion) of the data around expected returns in a more formal version of the definition.

$$\sigma_x^2 = E[X - E(X)]^2 \ldots (1.1)$$

The variance of a random variable X is represented by the equation above, where E(X) is the variable's expected value. The variance (σ_x^2) is calculated by multiplying the squared deviations from the expected value by their probabilities. To convert this risk measure in to simpler terms, the standard deviation is obtained (σ_x).

$$\sigma_x = \sqrt{E[X - E(X)]^2} \ldots (1.2)$$

Each investor has a unique risk profile which determines his willingness and ability to endure the risk. As the risk rises, investors expect higher returns to offset the risk. This relationship between risk and return is a very fundamental concept of finance and therefore it is important to deduce and evaluate the possible outcomes.

1.2 UNCERTAINITY

The absence of certainty or anything unknown is what we imply by the phrase uncertainty. It describes a circumstance in which there are severe options that all lead to the same results but the likelihood of that event is uncertain. This is due to lack of understanding or information about the current situation. As a result, defining or predicting future outcomes or events is difficult. Uncertainty can't be measured quantitatively with the help of models. Therefore, because the probabilities are uncertain, they cannot be applied to the probable outcomes. Risk is potential of loss; whereas, uncertainty indicates absence of certainty in the result of a particular situation. There are certain occasions where uncertainty is inherent with respect to the upcoming events. In a nutshell, risk refers to a situation in which there is a possibility of loss; while, uncertainty is a state of not knowing what will happen in the future.

Detailed distinction between risk and uncertainty are as below:

1. The position of gaining or losing something valuable is regarded as risk. Uncertainty is a state in which no one knows what will happen in the future.
2. Theoretical models can be used to measure and quantify risk. On the other hand, since future events are unexpected, it is impossible to quantify uncertainty.
3. In risk, the possible outcomes are known, while in uncertainty the consequences are unknown.
4. Risk can be managed if appropriate precautions are taken. Conversely, uncertainty is out of a person's or company's control because the future is unknown.
5. Risk can be reduced by taking required actions. In contrast uncertainty cannot be reduced.
6. Risk assigns probabilities to a set of events which is not possible to do in the event of uncertainty.

1.3 EXPECTED RETURN

If r is a rate of return, then its expected returns will be as follows, while substituting random variable as r of a security i:

$$E(r_i) = \sum_{i=1}^{Sn} r_i p_i \ldots (1.3)$$

Here, the expected return is summation of returns from a security i times probability for the return $r_{i.}$

1.3.1 Covariance of returns

Covariance is a statistical technique that can be used to determine when one security's price movement is linked to that of other securities. The direction of association between the stocks is reflected by the signs of covariance; if positive, both securities tend to move in the same direction. They prefer to withdraw away from each other if the association is negative.

For instance, the covariance among two securities, j and k, denoted by σ_{jk} or Cov(r_j,r_k) is calculated as

$$\sigma_{jk} = \{[r_j - E(r_j)][r_k - E(r_k)]\} \dots (1.4)$$

Where, r_j is the rate of return of security j and r_k is the rate of return of security k; whereas, E() is the expected rate of return of respective securities.

1.3.2 Correlation of returns

Correlation coefficient, another statistical concept, is derived from covariance. It is obtained by diving the covariance between two random variables, or in this case, two securities by the product of its standard deviations. Thus correlation between two securities can be determined with the help of the following equation:

$$\rho_{jk} = \frac{\sigma_{jk}}{\sigma_j \sigma_k} \dots (1.5)$$

The range of correlation coefficient is always between -1 and +1. If the value of ρ_{jk} = +1, then the returns on securities j and k have perfect positive correlation and move in the same direction. If ρ_{jk} = 0, the returns are unrelated and do not seem to follow one another. Whereas, if ρ_{jk} = -1, the securities j and k have perfect negative correlation and they move in the opposite directions. The correlation coefficient statistics is highly used in context of portfolio analysis where diversification amongst securities can help mitigate risk and earn maximum returns. Until now we have discussed by two securities, however, in real world there exist a bundle of securities to select from and build a portfolio.

1.3.3 Portfolio's expected return

The portfolio's expected return is the weighted average of the expected returns from the securities included in the portfolio. The equation for expected return r_p from portfolio p which consists of n individual securities is defined as:

$$E(r_p) = E\left(\sum_{i=1}^{n} w_i r_i\right) \dots (1.6)$$

Where, w_i is the weight of investment accumulated in security i to n.

1.3.4 Portfolio risk

The definition of risk for a portfolio of securities could be termed as variability of return, r_p. Considering, a portfolio of two securities for simplicity to determine the variance of the portfolio, the following equation is used:

$$\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_{12} \dots (1.7)$$

Where, σ_p^2 is the variance of the portfolio of two securities, w_1 and w_2 are of the weightage of investment of the two portfolios. In the same manner, portfolio risk of two securities and more can be calculated with the help of variance. The task therefore is to identify the risk associated with the portfolio which is relevant for rational decision making.

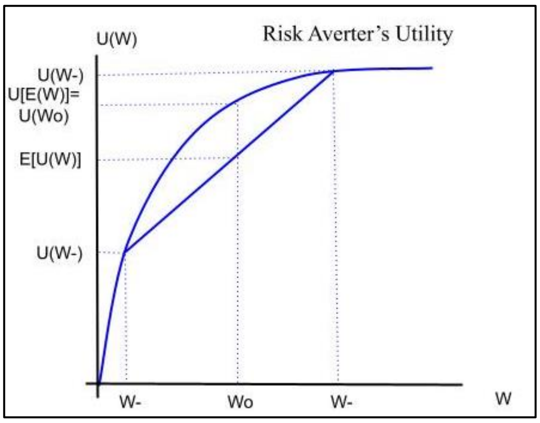
1.3.5 Risk attitude

When we talk about rational decision making, the attitude and preferences of an individual investor towards risk is an important factor. There are three types of risk attitudes: risk aversion, risk-loving behaviour and risk neutral behaviour.

1. Risk Aversion

A large pool of investor population fall under this category. These are conservative investors who prefer safety of principal over the possibility of a higher return and their investments are highly liquid. Expressing, the behaviour of a risk averse investor in terms of utility function:

Figure 1.2: Risk averter's utility



Source: Modern portfolio theory – Francis & Kim

The first derivative of the utility function corresponding to wealth, which is always positive, is used to calculate the marginal utility of wealth. This is predicated on the idea that having more wealth is always preferable to having less wealth. Symbolically, the first derivative is represented as:

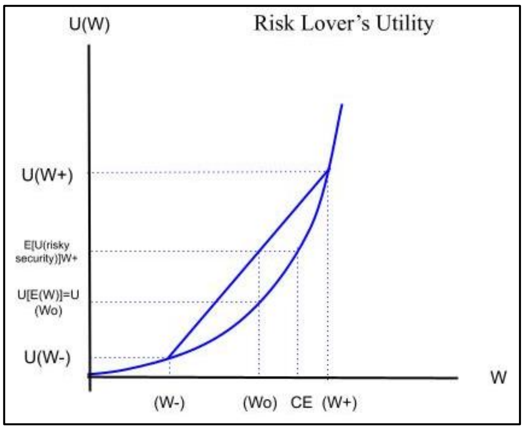
$U'(W) = \partial U/\partial W > 0$

The second derivative of the utility function, the slope of the utility determines whether the marginal utility is falling or rising. The above figure 1 demonstrates decreasing marginal utility of wealth. Since a risky investment has a lesser expected utility than a risk-free one with the same expected return at any point on the curve, this falling marginal utility of wealth results in risk aversion. Hence, a utility curve of a risk averse investor will always be concave to the origin.

2. Risk-loving behaviour

The case of a risk-loving investor is exact opposite to a risk averter. The utility function in this case will be convex to the origin. Indulging into a riskier asset will increase the utility by $E[U(W)] - U(W_0)$. The utility graph would be as shown below:

Figure 1.3: Risk lover's utility



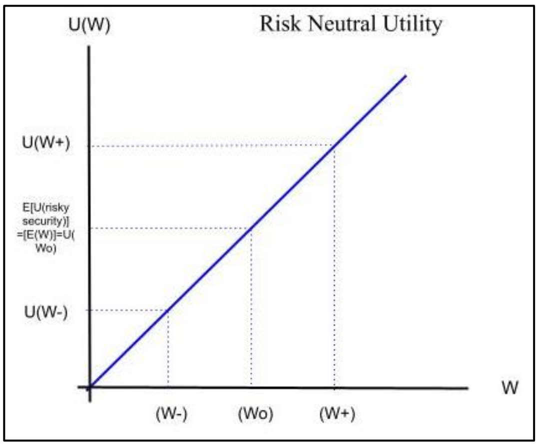
Source: Modern portfolio theory – Francis & Kim

Here, the distance between W_0 and CE (certainty equivalent) is the risk premium an investor would earn if he takes up a risky security.

3. Risk Neutral Behaviour:

This kind of behaviour is found in investors who are indifferent towards risky investments. Their utility function is linear and expected utility from investing, E[U(W)], is the same as their expected utility from not investing in risky securities, $U(W_0)$.

Figure 1.4: Risk neutral utility



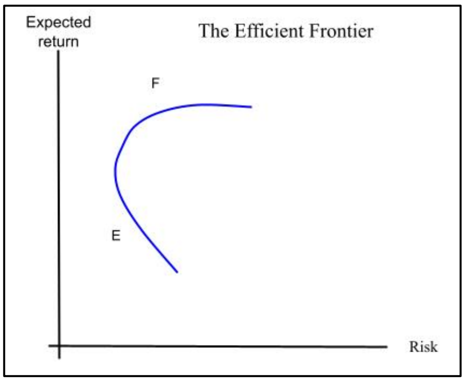
Source: Modern portfolio theory – Francis & Kim

We assume that investors act rationally and are risk averse since very few people prefer risk.

1.3.6 Risk Return trade-off - Efficient frontier

The equilibrium between the risk and the expected return in a capital market exists by posing various trade-offs between them. This relationship was initially formalized by Harry Markowitz in his paper “Portfolio Selection” published in 1952 by the Journal of Finance for which he was awarded a Nobel Prize. In the realm of Financial Economics, his portfolio theory became known as Modern Portfolio Theory. This theory is founded on four behavioural assumptions, the most important of which is that every investor perceives each investment opportunity as a probability distribution of returns over the same holding term. Second, the risk estimates of investors are proportional to the variability of returns as assessed by the standard deviation of variance of returns. Investors also make investment selections entirely on the basis of predicted returns and risk data. As a result, an investor's utility function U(r) is a function of expected return [E(r)] and return variability (σ). Lastly, investors are risk-averse and that they can construct an “efficient frontier” of optimal portfolios to maximize expected returns based on a given level of market risk. Thus, the portfolio generated are within a risk-reward context using mathematical programming and statistical analysis (such as variance and correlation) to reach the optimum allocation of the assets. These assets are called *efficient portfolios* and a set of efficient portfolios form *efficient frontier* depicted in the diagram below:

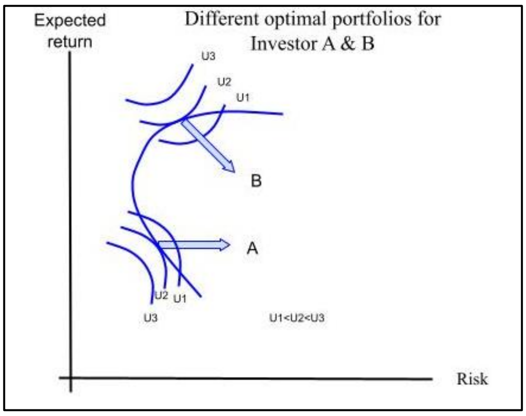
Figure 1.5: Efficient frontier



Source: Modern portfolio theory – Francis & Kim

The points on the curve between E and F are the efficient portfolios with the highest rate of return at various levels of risk. It is amongst these points that the investor should make the selection. To select one best portfolio the utility of returns function is used which are represented by the indifference curves which reflect the preference of the investor. The figure below shows the preferences of two investors – A & B, amongst which investor B prefers more risk than A. It can also be said that A is a risk-averse investor, whereas B is not.

Figure 1.6: Different optimal portfolios for Investor A & B



Source: Modern portfolio theory – Francis & Kim

1.4 CAPITAL ASSET PRICING MODEL

The Modern Portfolio theory is considered a major stepping stone towards the creation of the Capital Asset Pricing Model (CAPM) which has contributed to significant developments in financial economics. CAPM was introduced in the 1960s by Sharpe (1964), Lintner (1965), Mossin (1966) independently, which describes the relationship between systematic risk and expected returns that are used in pricing risky securities. The model assumes that investors are averse to risk, rational, and utility maximisers. It also assumes that the asset returns follow a normal distribution and the investor's sentiments are more or less similar making expectations and investment horizons identical. Further, it also assumes that a perfect capital market exists where transaction costs, taxes, etc. do not exist and investors have unlimited access to the risk-free rate.

According to the capital asset pricing model, investors are resituated for the risk taken and time value of money which is nothing but a risk-free rate. The formula for CAPM is as follows:

$$ER_i = R_f + \beta_i \,(ER_m - R_f) \; \ldots (1.8)$$

where, ER_i is the expected rate of return, R_f is risk-free return, $ß_i$ is beta of the investment, and $(ER_m – R_f)$ is a market risk premium.

The beta of an investment has a very important implication in terms of measuring risk. It measures volatility of stocks with regards to the overall market. The market benchmark index, in our case, would be BSE Sensex or Nifty50 have a beta of one and individual stocks are ranked according to how far they deviate from the overall market index. A stock with beta greater than one fluctuates more than the market over time. A stock's beta is less than one, if it deviates less than the market. High beta stocks are thought to be riskier but have a large return potential; whereas, low-beta stocks have a lower risk but lower return potential.

Beta is used to calculate the cost of equity investment and can have an impact on a stock's predicted rate of return. It is calculated by dividing the covariance of the return of an asset with the return of the benchmark by the variance of the benchmark's return over a certain period.

$$Beta = \frac{Covariance}{Variance} \ldots (1.9)$$

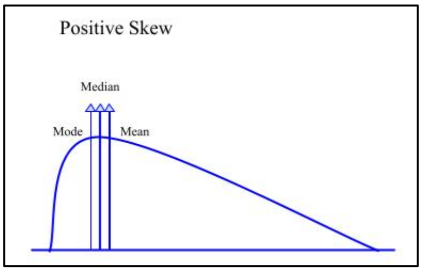
When analysing risk, the price variability of a stock is vital to consider. If risk is considered as a probability that a stock will lose value, than beta can be used as a risk proxy. Furthermore, beta is a straightforward, quantitative metric that is simple to use given that beta varies depending on factors such as the use of market index and the time period being examined. However, there are a few shortcomings of beta. Firstly, it does not include any new information. Secondly, betas reveal very little about what lies in the future. Beta of a single stock has a tendency to fluctuate over time making it unreliable. It is an excellent measure for investors to purchase and sell equities in short periods of time. It is, however, less effective for investors with long-term objectives. Finally, beta as a risk proxy does not differentiate between price movements – upward and downward. Downward movements represents risk while upward movements represents an opportunity. Since beta does not distinguish between the two it is of little help to the investors. Financial analyst usually recommend low beta equities for conservative investors; whereas, high beta companies for risk savvy investors.

The objective of the capital asset pricing model is to assess whether a security is fairly-valued when its expected return is compared to its risk and time value of money. Although various assumptions of the model are not practically applicable the simple CAPM model is widely being used because of its simplicity and easy comparability of investment alternatives.

1.4.1 Shortcomings of Capital Asset Pricing model

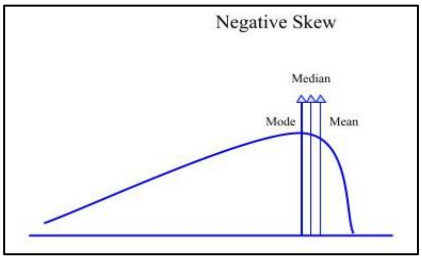
One of the major shortcomings of the simple CAPM model is that its results rest heavily on normal distribution of returns. To overcome this, the capital asset pricing model was extended to include skewness and kurtosis of the distribution as suggested by Kraus and Litzenberger (1976). This model is said to be the four-moment capital asset pricing model that has been studied and empirically tested by various academicians. Skewness and Kurtosis are said to be the shape characteristics of the securities included in the portfolio and provide insights into the distributions of the returns. Skewness is the third moment that depicts the clustering of the returns on either side of the tail, a degree of distortion from the symmetrical bell curve in a probability distribution. These distributions demonstrate either right (positive) skewness or left (negative) skewness to varying degrees.

Figure 1.7: Positive skew



Source: Mathematical statistics by Gupta & Kapoor

Figure 1.8: Negative skew



Source: Mathematical statistics by Gupta & Kapoor

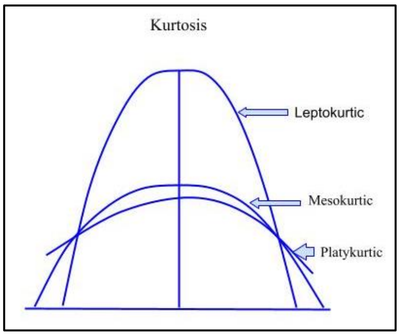
A normal distribution has a skewness of zero and is represented by a bell-shaped curve, whereas a distribution with data concentrated on the right side has a longer or fatter tail on the right side, and a distribution with data concentrated on the left side has a longer or fatter tail on the left side. The stock market's distributional behaviour is observed to be negatively skewed, with two forms of asymmetries in stock returns.

1. Skewness in the distribution of individual stock returns.
2. Asymmetry in the dependence between the stocks

Generally, stocks appear to be highly correlated during market downturns in contrast to market upturns and hence the presence of such uncertainties challenge the assumptions of normally distributed security returns. Thus, in a non-normal distribution, it is difficult to diagnose the correlations between variables in such extreme scenarios using the standard correlations measures. Therefore, to detect such correlations a sophisticated technique is needed to be used such as copula.

In contrast to skewness which measures extreme value in one tail versus the other, kurtosis, which is the fourth moment, measures extreme values of the returns of distribution in either side of the tail. In a normal distribution, the value of kurtosis would be three standard deviations (mesokurtic), while in presence of extreme returns (either leptokurtic or platykurtic) kurtosis is more than + or – three standard deviations from mean which is called kurtosis risk.

Figure 1.9: Kurtosis



Source: Mathematical statistics by Gupta & Kapoor

Theoretically, if any security is skewed or has a tail thick/thin on both ends (higher kurtosis), then beta alone is not enough to price the securities and therefore there is a need to include higher moments in the pricing model which eventually leads to the formation of Higher Moment CAPM. This model includes co-skewness and co-kurtosis.

Another drawback of the CAPM model is that the model does not explain the systematic differences in returns on value versus growth stocks having known that the returns distribution of these stocks differ ultimately giving rise to value anomaly. Additionally, there is also a possibility of an interaction effect between skewness and kurtosis, and the influence it has as a price factor is a less researched area. Lastly, when CAPM is used for capital budgeting for choosing which project will add the most value and maximize profits it is believed that the inclusion of higher moments in the model translates to the cost of equity. The rejection of the CAPM model also followed in papers by Fama & MacBeth (1973), Roll (1977), Fama and French (2004).

1.5 OTHER MEASURES OF RISK

After discussing standard deviation and beta two of the most common measures of risk, now we discuss the other measure of risk which are Sharpe ratio, Treynor ratio and value at risk.

1.5.1 Sharpe ratio

Sharpe ratio, developed by William F. Sharpe, a Nobel laureate, introduced as a measure for the performance of mutual funds where he proposed the term 'reward-to-variability' ratio (Sharpe, 1966). The ratio helps investors to comprehend the return on an investment in relation to its risk. The risk-to-reward ratio is one of the most extensively used risk-to-reward indicators in finance, and its popularity can be attributed to its simplicity. The ratio depicts how much extra return one receives in exchange for the riskier asset's heightened volatility. The formula for calculating Sharpe ratio is as below:

$$Sharpe\ ratio = \frac{R_p - R_f}{\sigma_p} \ldots (1.10)$$

Where, R_p is return of portfolio, R_f is risk free rate and σ_p is standard deviation of portfolio's excess return.

To assess the relation between the Sharpe ratio and risk, the standard deviation, generally known as total risk, is commonly utilised. The risk free rate of return is used to analyse if the increased risk of the asset is appropriately compensated for the asset's added risk to the investor. A good Sharpe ratio is the one that is greater than one and considered acceptable by investors. If the ratio is higher than two it is considered to be very good and the one that is greater than or equal to three is ranked as excellent. Sharpe ratio that is under one is thought to be sub-optimal by investors.

The underlying issue in the ratio is that it assumes all asset returns are properly distributed. Because standard deviation is ineffectual in the presence of these flaws, kurtosis (longer tails and larger peaks) or skewness is a problem for the ratio. When returns are normally distributed, using this formula is problematic. Secondly, the ratio also can't differentiate between upward and downward risk. It is concerned with volatility and not its direction. Moreover, Sharpe ratios are backward-looking and take historical returns and volatility into account. The ratio-based decisions assume that future performance will be comparable to that of the past.

Further, another measure Treynor's ratio (Treynor, 1966) measures the performance of the asset by determining how much excess return was generated for each unit of risk taken by a portfolio also termed as reward to volatility. This ratio considers the systematic risk measured by portfolios beta. Nevertheless, this ratio is accused of being backward-looking which means investments are likely to behave differently in the future than they did in the past. Sharpe ratio, Treynor ratio and various other ratio's such as Jensen ratio (Jensen, 1968) are methods to rank the portfolios rather than measuring their risks.

1.5.2 Value at Risk

Value at risk (VaR) invented as a concept by J.P. Morgan did not emerge until the late 1980s. The stock market crash of the 1987 was the catalyst when a large number of academically qualified quantitative financial techniques were in positions to be concerned about the firms long term volatility. The crash was so implausible that it questioned the fundamental foundation of quantitative finance. Some quantitative financials after studying the history concluded that there were repeating crises, about one or two each decade, that overpowered the statistical assumptions inherent in models used in trading, investment and for various other purposes. These impacted a large number of markets, including those which were previously unrelated, and had little clear economic basis or warning. If such events (crises) are factored into quantitative techniques, they would have dominated the analysis and led to strategies which might not work on a daily basis. However, if these events are ignored than the gains made in normal days could be significantly lower than the losses incurred during the crises which may lead to catastrophic impact on the economy and its institutions. These events or crisis are termed as 'black swans' by Nassim Taleb in his book *The black swan* published in 2007.

VaR was created as a systematic method of separating extreme events, which are researched quantitatively over long period of time and across wide market events. It was expected increase in estimated VaR breaks would raise a red flag before the occurrence of the crisis. VaR measures the magnitude of potential financial losses inside a company, portfolio, or positions over a given period of time. Investment banks and commercial banks are the most typical users of this tool to analyse the extent and likelihood of potential losses in their portfolios. It's a risk management tool that helps risk managers measure and manage risk exposure. Financial institutions can utilise the data generated by VaR modelling to determine if they have sufficient capital reserves to absorb losses or if beyond acceptable level of risks need them to minimize risky investments.

Another very famous and widely used method around the globe to measure risk considering the normal distribution is the value at risk statistics that assess and evaluates the level of financial risk inside a corporation, portfolio of assets over a specified time frame. It is defined as the maximum rupee amount expected to be lost over a given time horizon, at a pre-defined confidence level, and is used to measure as well as control the level of risk exposure. There are three methods of estimating value at risk namely, historical method, variance-covariance method, and Monte Carlo simulation method. The historical method ideally re-organizes actual historical returns from worst to best and then assumes that history will repeat itself from a risk perspective. The variance-covariance method is quite like the historical approach with the exception that the bell curve is used to represent the actual return data. It estimates only two factors that are expected return and standard deviation which are plotted to a normal bell-shaped curve to identify where the worst 5% and 1% lie. Lastly, the Monte Carlo simulation method performs risk analysis by developing a model that substitutes a range of values (here, future stock price returns) by running multiple hypothetical trails to obtain results over and over each time using a different set of random values from the probability distribution.

Despite the wide usage of the value at risk method by investors, bankers, and academicians it suffers from various drawbacks. It essentially does not indicate the size of the loss associated with the tail of the probability distribution out of the confidence level. Additionally, it does not take correlations into account and hence the value at risk figures of components of a portfolio do not add to the value at risk of the overall portfolio. Lastly, the different methods of calculation of value at risk give different results. The financial crisis of 2008 brought these issues to light especially related to the value at risk method, since the calculations understated the potential occurrence of risk events and the risk magnitude posed by portfolios of subprime mortgages. Subsequently, this led to the institutions not being able to compensate billions of dollars in losses as the value of subprime mortgage plummeted.

Alternatively, the Sharpe ratio which is the average return earned more than the risk-free rate per unit of volatility or total risk is used to measure risk. The major drawback of all the above-mentioned measures of risk lies in its innate assumption of normality. In the real world, the returns are not normally distributed, they either have a fat tail or thin tail on one side or both sides. Stock market crash or financial crises that have occurred throughout history are evidence of the presence of uncertainty and unpredictability of the market. Also due to the rapidly evolving financial markets, it becomes very important to manage risk-taking into account the non-gaussian distributions. The fluctuations in the stock market indices cause changes in the statistical distributions of the empirical data whose analysis and study of parameters will make it easy to predict possible future crises.

1.6 EMERGENCE OF OTHER DISTRIBUTIONS

Over the years, financial economics literature has been hemmed in with studies pertinent to normal distribution. The first-ever and major empirical objection of the CAPM model based on normal distribution was by Mandelbrot in 1963. In his analysis of cotton, prices observed that not only are the returns non-gaussian but they also show ‘time-scaling’. He argued that the data appear to be in a form of Paretian distribution rather than a normal distribution. This and the pronounced tail prominent from his analysis made Mandelbrot consider a levy stable distribution consistently followed by the returns. Gaussian distributions are inadequate in modelling high variability since they do not allow for large fluctuations; however, this is not the case for non-gaussian distribution since they do not share such limitations. It is pointed out in the literature that levy distribution fits better than Gaussian distribution but it lacks enough theoretical material. Another distribution known as a Laplace distribution is used to model the returns distribution which has an unusual, symmetrical shape with a sharp peak and tails that are longer than the tails of a normal distribution. However, the density of probability distribution of Laplace is continuous and not differentiable in the centre, and therefore it is necessary to explore other distribution functions to model the behaviour of the stock returns.

One of the more simpler, robust and conservative distribution is the student t distribution. Frederick R. Helmert, in the late 1800s, is credited with the earliest recognisable description in the literature. However, William Gossett in 1908 is credited with the current and more frequently recognised description. He used the pen name 'Student' because he worked for the Guinness brewery, which did not allow him to use his own name, according to mythology. To reflect the pseudonymous authorship of this initial publication, the t-distribution is also known as Student's distribution or Student's t-distribution.

T distribution is amongst the family of distributions that resemble the normal distribution curve but are a little shorter and thicker. It is a form of probability distribution that has a bell shape and heavier tails than the normal distribution. The larger tails are due to the fact that T distributions have a higher possibility of extreme values than normal distributions. The t-distribution, as opposed to the regular normal distribution, assigns more probability to observations in the tails of the distribution. The degrees of freedom parameter of the T distribution determines tail heaviness, with smaller values indicating heavier tails and higher values resembling a typical normal distribution with a mean of 0 and a standard deviation of 1.

A wide range of literature have shown that many financial asset return distributions have larger tails than the normal distribution. Tail distributions is a very important implication for financial time series since the probability of observing extreme values is higher for fat-tail distributions compared to normal distributions, it leads to a gross underestimation of risk. A random variable with more extreme values than normal distribution is considered to be possessing fat tails, the perfect example of which is the stock market. The stock market returns distribution has more relatively larger and smaller returns than one would expect in a normal distribution. Moreover, the excess kurtosis establishes the fact of fat tails and evidence against normal distribution. As a result, the Student-t distribution is particularly suited to dealing with fat-tailed and leptokurtic features and can be used as a model for financial returns with excess kurtosis. Keeping the same in mind, this study has made use of student t distribution for the analysis rather than normal distribution.

1.7 STYLIZED FACTS

1.7.1 Volatility

Portfolio allocation and risk management are heavily reliant on asset return volatility and correlation. A growing body of literature in financial economics has centred on time series models for asset return volatility and co-movements. This section is going to discuss in detail the volatility associated with each sectors, while the next will focus on correlation among the sectors. Volatility is important for various reasons: the larger the price swings in an investment, the more difficult it is to remain emotionally unconcerned. The price volatility of a trading asset can be used to determine the size of a portfolio's position. Moreover, price volatility also provides opportunities to buy assets at a low price and sell them when they are costlier. Therefore, the investors care a big deal about volatility.

Volatility measures the dispersion of price rather than measuring the direction of change because while computing standard deviation (or variance), all differences are squared, resulting in a single quantity that includes both negative and positive differences. The predicted returns of the two assets with differing volatilities may be the same, but the instrument with higher volatility will experience larger fluctuations in value over time. Volatility can be estimated by using implied volatility. This is common for options traders but it does require traded market price and given the market price variance can be obtained. So implied volatility reverse engineers from the market price and solve for the volatility that would be needed to plug into the model to get that market price. It is a forward looking as opposed to other volatility approach which is based on historical information. Stochastic volatility, on the other hand is non-deterministic, its volatility changes over time and it encompasses changes that are innovations based on information and random changes.

Modelling volatility is the subject of a considerable body of research. The unconditional volatility models, in which volatility is assumed to remain constant, are quite well-known in the literature. Scholars later realised that volatility cannot be constant because it changes over time and shocks last a long time. As a result, numerous conditional volatility models have been created to represent the volatility persistence aspects in conditional variance have been developed. The most widely used are the autoregressive conditional heteroscedasticity (ARCH) and extended ARCH (or GARCH) models introduced by Engle (1982) and Bollerslev (1986), respectively.

1.7.2 Stylized facts

In the realm of finance, we are confronted with risk on a daily basis. If we could accurately foresee how prices would appear in the future, we would be spared the agony of making decisions based on insufficient information.

Many practitioners and academics have attempted to develop financial models to aid them in their decision-making, but are these models completely accurate? Do they truly represent the movements of asset prices in reality? Can we really rely on the Black-Scholes-Merton model (Black & Scholes, 1973; Merton, 1973), which assumes that returns are log normally distributed? Can GARCH models effectively capture volatility? Empirical data from a variety of assets has revealed that financial time series data has common qualities, such as it turns out that we can generalise that most, if not all, asset return time series have these common features. Stylized facts are the term for these common characteristics. The study explores these stylized facts by categorising them based on the information we may get from them about asset returns. Further, it investigates the distribution properties of asset returns, their dependence qualities, and additional properties that cannot be categorised in either, as well as some insight into asset correlation. The discussion is to help users of financial models, as well as financial modellers themselves, gain a deeper and more realistic understanding of these models by demonstrating their limitations.

"Stylized facts" was first coined by the macroeconomist Kaldor, he proposed that scientist should be permitted to begin with a stylized interpretation of the facts. He developed a series of statistical facts governing macroeconomic growth and used them as the basis for theoretical modelling (Kaldor,1961; Chakraborti et al., 2011a). Later on, this concept was coined to explain various statistical regularities in financial asset return series that are consistent across markets, kinds of assets, period of time, and return time scales, among other things. A number of stylized properties are now widely accepted because of enormous data availability and large transactions recorded in huge databases.

A series of research shows that asset prices exhibit different statistical properties and the risk associated with these financial assets can be summarized by the variability of financial returns distribution. These variations found in the prices are not normal and exhibit some ambiguous empirical irregularities known as stylized facts. Stylized facts, by definition, are empirical observations that are almost true and agree with theories over a wide range of instruments, marketplaces, and time periods (Cont, 2001, 2008). These should be viewed as constraints that a stochastic process has to verify to reproduce the statistical properties of the returns accurately. The focus is to capture the information of the data set and its properties in a significant manner.

The stylized facts of asset returns can be classified into: distribution properties, dependence properties and other properties. The distribution properties include heavy tails and aggregational gaussianity. Dependence properties include absence of autocorrelation in linear functions, slow decay of autocorrelation in absolute returns, volatility clustering. The other properties include leverage effect, gain/loss asymmetry, volatility persistence, long memory and volume-volatility correlation. These facts are universal patterns of behaviour that are unaffected by time, place, or specific structural intricacies (Mukherjee et al., 2011).

Distribution Properties :

In finance, one of the most widely used statistical distribution is the normal distribution. A lot of financial theories and concepts are anchored by the normality assumptions, for instance, the modern portfolio theory. One of its fundamental assumptions is that if the assets that make up the portfolio have a multivariate normal distribution, then the distribution of that portfolio, or any other portfolio made up of the same set of assets, will be normal. Another theory the Black-Scholes-Merton model reminds us that among the factors required to price an option are stock prices and return volatility, thus it's critical to distinguish between the two. The model implies that prices are distributed in a log-normal manner. This means that the returns, which are normally calculated as log returns, follow a normal distribution. However, while the normal distribution is the most widely accepted distribution assumption, it is also one of the most widely disputed. Many empirical studies have discovered that asset returns are not normally distributed in general. Two stylized facts will be used to demonstrate why this is the case. The appearance of heavy tails is the first feature that argues against the normalcy assumption. Simply put, extreme asset return numbers, whether positive or negative, are likely.

Mandelbrot (1963), suggested that stock returns were leptokurtic and found that in actual-world financial markets do not follow Gaussian distribution and developed levy stable distributions that have an infinite variance. He was the first to introduce the concept of fat tails and deduced that markets respond to new information with large price movements (volatility) when a market suffers a volatile shock, more volatility should be expected. Inspired by Mandelbrot, Nassim Taleb’s (Taleb, 2007) writings on fat tails have largely contributed to their prominence in mainstream finance discourse, the black swan events being rare leave a profound impact on the economy. Most people ignore the study of such events because of their rarity and lack of data and since these rare events are a dangerous source of risk and have the potential to destroy huge financial instruments and systems.

In 2001, Rama Cont, an Oxford professor of mathematical finance, discovered that different types of assets are actually out of the ordinary. He calculated kurtosis using five-minute price increments of three asset classes: the S&P 500, and two currency futures. the Deutschmark and the Franc Suisse. He discovered that all three assets had excessive kurtosis. In a separate study in 2010, three economists from Poland showed that in value at risk calculations, heavy-tailed models should be used to obtain acceptable estimates of market losses. Kurtosis, which measures how heavily distributed the tails are in a normal distribution, has a value of three. A higher kurtosis value indicates a heavier tail distribution, which suggests greater likelihood for extreme values.

Borak, Misiorek and Weron (2010) utilise a sample of daily log returns from the Dow Jones and the Polish WIG20 index to determine the fit of the sampling distributions to the population distribution. They tested the fit of normal distribution and three non-normal distributions – hyperbolic, normal-inverse gaussian and stable. For both the measures they used they found out that lower the value, the better the fit. Non-normal distributions such as hyperbolic normal, inverse gaussian, and stable have a better fit than a normal distribution in sampling the two sets of equity in this. This is yet another proof that normality is difficult to observe in asset returns, though it is not impossible.

The concept of aggregational gaussianity indicates that as the time scale or measuring asset returns increases distribution becomes normal. In 2000, Rydberg described the unique property of log-returns over longer time-scales as equivalent to temporal aggregation, that is. This means that log returns denoted by the differences between the natural logarithm of two asset prices at different time is simply the sum of difference between the two natural logarithms from smaller time scales. In two separate study conducted by Kendal (1953) and Fama (1965), observed that log returns of equity instruments are indeed non-normal over short timescales. Another study, Eberlein and Keller (1995) and Rydberg (2000) found that these distributions tend closer to normal when measured over longer time scales. Cont (2001) coined this term as aggregational gaussianity, a stylized fact of asset returns.

Dependence Properties :

In this part, we'll look at the statistical features of long-term asset return dependence. The following are some of the questions we're attempting to answer: are future returns dependent on previous information? Is volatility random or does it depend on recent historical volatility events? How are returns and volatility related to one another over time?

The absence of linear autocorrelation, or the observation that for linear measures of return the past information is not useful in predicting future information, is the third stylized fact. This stylized fact is congruent with the efficient market hypothesis, which states that even in a weakly efficient market, past data should not be able to produce higher returns. If this is not the case, an arbitrage opportunity will arise due to the ability to use past data, which will result in swift market activity, and the arbitrage opportunity will vanish in a matter of minutes in larger markets such as the foreign currency market. Several statistical methods that rely on prior data, such as the autoregressive moving average model, should be used with caution as a result of this statistical observation, as they may not adequately discriminate white noise from the actual essential information.

The fourth stylized fact is that, unlike linear measures of returns, autocorrelation in absolute returns decays slowly. For absolute returns, previous data for non-linear measures of returns has predictive information, i.e., the past does represent the future for a long time. The autocorrelation function quantifies autocorrelation as a function of pass information, a power parameter alpha, and an assumed time lag. For various powers of non-linear returns, autocorrelation slowly disappears or decays with time. It was also discovered that when the power parameter alpha, which indicates absolute returns, is equal to 1, the autocorrelation decay is the longest. The discovery of slow decay prompted the development of other non-linear measurements and explained the leverage effect, which will be explored later.

Volatility clustering, or the observation that large price variations are followed by large price variations, is the fifth stylized fact. It was discovered that absolute or squared returns are autocorrelated or persistent, meaning that when an event causes significant price movement, it is frequently followed by another significant price movement before volatility returns to normal. As a result, absolute or squared returns are observed to have multiple variances, or heteroscedasticity. This fact is one of the reasons why ARCH and GARCH models are useful in financial econometrics.

Other stylized facts :

The sixth stylized fact is the leverage effect. An key element of asset returns that was first discovered by Black in 1976 is that sudden price decreases are followed by high volatility applied to equities prices. A drop in value means the debt to equity ratio increases, which is a measure of financial leverage, hence the name of the effect. The asset’s volatility is negatively correlated with its returns. Here, the decline in volatility is along with the rise in price and vice versa. Black (1976) and Christie (1982) developed a possible explanation for this: as the price of the asset decreases, companies become more leverage because the value of debt rises as compared to that of their equity making the stock riskier and volatile. Therefore, this phenomenon is called the leverage effect which is in general asymmetric.

The following stylized fact, gain loss asymmetry, or enormous losses being more common than large gains, is closely related to the leverage effect. The returns distribution of the market show autocorrelation of returns to be insignificant except for very small time intervals i.e., 20-10 minutes. Moreover, during market downturns, there is a huge fall in market value but the same could not be said for upturns which are known as gain/loss asymmetry.

After establishing that volatility sticks, GARCH models have been particularly useful in predicting volatility. However, in 1976, Black also noted that price decreases are followed by high volatility more frequently and strongly than price gains of the same magnitude. As a result, we'll need to adjust our GARCH models to account for the asymmetry. One approach to do this is to use an EGARCH or exponential GARCH model that demonstrates the asymmetry. This asymmetry can be visualised by the help of news impact curve which shows the effect of good news and bad news on volatility. Engle and Ng(1993) showed that models should consider news impact curve to differentiate the consequences of good news and bad news.

Moreover, today's return has a significant effect on the unconditional variance of many periods in the future which is known as volatility persistence. As noted by Mandelbrot 'large changes tend to be followed by small changes'. This means that there are extended periods of high market volatility followed by a period of lower volatility. When a market experiences a volatile shock, more of it is followed given rise to the phenomenon of persistence of volatility shock.

In the modelling of financial data, the dependence structure across time plays a significant role. Many financial time series have been discovered to be unusually persistent, implying that an unanticipated shock to the set of variables has long-term ramifications. As demonstrated by Robinson, recording long memory (also known as long-range dependence, strong dependence, or persistent) in financial time series of asset returns has sparked a lot of interest in this context (2003). Many exceptionally durable financial time series can be well described by long memory processes.

To identify long-range from short-range processes, auto covariance functions are widely used. In short-range dependent processes, the interaction between values at different times reduces rapidly as the time difference rises. After a particular time lapse, either the auto-covariance decreases to zero or it decays exponentially. Long-range processes, on the other hand, have much higher coupling, resulting in a power-like decay of the auto-covariance function, which is exponentially slower. The existence of long-term memory indicates that the market does not respond to new financial market information immediately, but rather gradually over time.

As a result, historical price movements can be utilised to estimate future changes in the price. This finding has significant ramifications for market efficiency.

There's a cliché on Wall Street that it takes volume to change stock prices, and there's a lot of research on the relationship between trading volume and volatility indicators. When the stocks are bought at large then the value of the stock increases a few minutes later whereas when the stocks are sold at large then the value of stock decreases. The relationship between the volatility of the stock and its value depends on the types of trading orders. This may occur if the company reports unexpected earnings either better than expected or lower than expected. It could also be as a result of positive or negative news from a firm or the industry as a whole.

The clark's model from 1973, which states that the daily price change is the total of a random number of 15-day price changes, was noted by Tauchen and Pitts (1983) as one possible explanation for the association between volume and volatility. He claims that if a daily price change variance is a random variable with a mean proportional to the mean number of daily transactions and trading volume is associated positively to the number of within-day transactions, then trading volume is related positively to price change variability.

The second explanation is the epps and epps' model, which was developed in 1976 and looks at the mechanics of day trading. In this model, the change in market pricing inside transactions is the average of the changes in traders reservation prices. They assume that there is a positive relationship between the extent to which traders disagree when they revise the reservation prices and the absolute value of the change in the market price. If the trading volume is positively related to the extent to which traders disagree when they revise the reservation prices, then the price viability volume relationship arises. These two models are complementary and provide valuable insight into speculative market behaviour. Another theoretical explanation for this phenomenon is that the arrival of new information, which is a common and observable element, drives both volume and volatility. This idea, often known as the mixture of distribution hypothesis, states that volatility moves in lockstep with unexpected trading volumes.

The studies discussed indicate how the risky nature of the assets used in financial series makes it difficult to create a model that truly captures their underlying features. Despite this, certain generalisations based on actual data can be made. It is at most important to be aware of the stylized facts (characteristics) of the financial assets returns when building models that represent asset price dynamics, the model must be able to capture these properties. These are based on the properties of the empirical data which provides the investor and researcher new insights with the help of non-parametric methods. They are theoretically model-free and provide quantitative information about the underlying financial time series.

Therefore, having a basic awareness of the stylized facts of the returns and risk of the market is important especially for investors who are susceptible to market manipulation. The recent stock market crash is a clear example of how a lack of understanding of the capital market may lead to excessive optimism. Small investors' lack of market expertise is said to make it simpler for large players to manipulate the market.

1.8 SECTORAL ALLOCATION

Portfolio management entails establishing portfolios and enabling them to evolve in order to meet the investor's return objectives while adhering within the investor's risk and asset allocation limits. There are two ways of constructing portfolios: the bottom-up strategy and the top-down approach. The first is the more conventional and older of the two. It centres on picking individual stocks. Managers are assessed on their ability to identify assets that perform better than the average performance of assets in the same class or sector. The second places a greater emphasis on sector selection rather than individual stock selection. This latter strategy is supported by research that shows that the allocation of different industries has the greatest impact on portfolio performance. As a result, portfolio management is progressively moving toward a top-down perspective. The top-down investment process is divided into two phases: strategic sectoral allocation and tactical sectoral allocation.

Sector allocation is the process of allocating distinct sectors within a portfolio. It examines economic fundamentals on a sector-by-sector basis. At the outset, investors determine the type of sectors they want to include in their portfolio based on their goals and limits. Sectoral allocation can be carried out in two phases. First, the long-term allocation is determined based on each sector's risk and return estimates. This is an example of strategic allocation. Then, based on short-term projections, modifications are made. This is what tactical allocation is all about.

In the investment management process, sectoral allocation is crucial. The results of modern portfolio theory (Markowitz, 1952) can explain why people are interested in sectoral allocation. The latter implies that financial markets are well-regulated enough for asset values to be in balance. As a result, the prospect of making significant gains only through stock selecting is diminished. He went on to illustrate that an asset's risk was determined by its volatility and correlation with other assets in the portfolio.

In the past, sectors were regarded to be somewhat less relevant in understanding stock returns than other factors. The most well-known studies illustrating the unimportance of the sector were published in the 1970s.

Bruno Solnik (1974) shown in his landmark research on the benefits of international diversification that diversification across developed countries reduces risk more than diversification across main sectors of an economy. Solnik's findings were confirmed by Donald Lessard (1974, 1976), who suggested that factors other than sector were the primary drivers of security price returns. After embracing these results, traditional financial advisors and investment managers have used country identification as a significant strategic choice component for international investments.

However, certain academic studies published in conjunction with the launch of the SPDR funds, commencing at the close of the twentieth century, cast doubt on those earlier conclusions. Brinson Partners, in collaboration with Duke University, conducted a research in 2000 that looked at a factor model for the 21 nations that make up the current MSCI World Developed Markets universe. The research looked at 21 developed equities markets from December 1985 to November 1999. According to their findings, sectors have become a more important component of security returns. More importantly diversification between sectors reduces risk more effectively than diversification across countries. They further added that the importance of sectors in determining stock returns has increased dramatically.

Therefore, diversification at the country and sector levels has become even more important as the global financial climate has changed and new economic powers have emerged in recent decades. Emerging capital markets, such as those in India and China, are steadily expanding, attracting an increasing number of international investors. However, not all areas of the economy are rising at the same rate. As a result, the investment prospects of companies in different areas may differ. In such economies, it is vital to examine diversified sectors performance and prospects while making investment decisions.

Major Sectors -

Sectors can be broadly classified into 9 major sectors discussed below:

1. Basic materials
2. Consumer discretionary goods and services
3. Consumer durables
4. Energy
5. Financial
6. Healthcare
7. Industrial
8. Information Technology
9. Utilities

1. Basic materials

Basic materials include chemicals, metals and mining, and steel. The majority of enterprises in this sector produce commodities with sales prices that align with production costs, particularly in low-inflation settings like we've seen in recent years. These companies are usually heavily in debt and have limited long-term growth potential. The sector can fare well during periods of high inflation.

2. Consumer discretionary goods and services

Consumer discretionary goods and services include automobiles, building and construction, publishing, and retail. These stocks, like capital goods, perform badly in downturns but well in upturns. Overall interest rates have less of an impact on this industry.

3. Consumer durables

Consumer durables include beverages, food, and tobacco. This industry has a history of weathering economic downturns. Consumer goods companies are intriguing since their overall volatility is low and their growth prospects are promising. The industry is a solid defensive investment during adverse economic times.

4. Energy

Oil and gas, as well as drillers, are examples of energy. The oil industry has a different dynamics than the basic materials group as a result of restrictions posed by the OPEC cartel. Oil prices have risen from $15 per barrel in the 1990s to more than $100 per barrel presently, making the energy sector one of the most enticing in the previous 20 years. Many energy equities are especially appealing because of their above-average dividend pay-outs.

5. Industrials

Industrials include aerospace/defence and electrical machinery. The industrial sector is primarily made up of equities from the "old economy." This organisation is towards the end of its life cycle, with little opportunities for future expansion. This sector can offer excellent investment returns during times of economic resurgence, but overall performance is projected to be subpar.

6. Healthcare

Healthcare sector include pharmaceuticals, medical instruments, biotechnology and primary care. This is also a crisis industry; when you need medicine, you need medicine. Pharmaceutical companies that have been around for a long time provide generally reliable results. Biotech firms provide astronomical gains at the cost of more risk. Hospitals and other health-care institutions add to the sector's diversity.

7. Financials

Financials include major banks, insurance and brokerages. Interest rate movements used to be closely connected with stock values in this industry. Companies have improved their ability to manage interest-rate risk in recent years, but stock values still tend to rise when rates fall. In recent years, consolidation and cost management have become far more important drivers of financial stock prices. Banks and finance corporations typically do poorly during recessions, as bad loans rise and transaction income declines. Insurance businesses, particularly property and casualty insurers, experience a loss when underwriting competition drives down premiums .

8. Information Technology

Information technology include semiconductors, the internet, and software. The same forces apply to this sector's growth as they do to other capital goods. Even in times of tremendous demand, organisations are vulnerable to "paradigm changes" (e.g., mainframe computers are being replaced by desktop computers and now laptops). This sector is regarded as the most unstable of all economic sectors.

9. Utilities

Utilities include electricity, water, and gas. They are businesses that purchase and resell commodities like electricity, water, and natural gas. Companies in charge of power generating and infrastructure maintenance fall into this category. During recessions and periods of sluggish growth, this industry also performs well. This sector's companies are considered protective, and their dividend yields are greater than the average.

Financial markets attempt to forecast the economic outlook of the country quite ahead of time. As a result, the market cycle tends to come before the economic cycle. This is vital to remember because the market starts to predict a rebound even when the country is in the midst of a recession. When the economy is contracting, interest rates are being decreased by central banks, and consumer expectations have bottomed, the basic materials, information technology, and industrials sectors have historically performed best. Industrials, information technology, consumer discretionary goods and services, and energy have all performed well during early recovery periods when the economy has begun to recover from its low point, resulting in increased consumer spending, increased industrial production, and an upward sloping yield curve.

In the late recovery stage the sectors such as energy, consumer durables and healthcare supposedly perform better when the interest rates are rising, yield curve is flattening, and consumer spending, industrial production is declining. Whereas, during early recession, when the economy is suffering from waning GDP, interest rates are high, consumer spending is in the trenches along with industrial production, sectors such as healthcare, consumer durables and utilities perform better. Therefore, in consideration of the business cycles and the favourable sectors the investors can assign weights to each sector keeping in mind the ongoing and future stage of business cycle. Having discussed this now we move on the correlation that we have been stressing on from the start. Correlation is at the centre of portfolio building and management. Hence studying them is equally as important.

The correlation of sectors with the market index is either high or low and therefore change in one may cause change in the other sectors causing a ripple effect in the market. This makes it all the more important for investors to understand the correlation so that they can make the best of diversification of risk through investing in various sectors that are positively, negatively or less correlated. A series of assets having low correlations to one another is the mathematical product of diverging returns. Sectors with minimal correlations are great prospects for asset allocation. Individual sectors not only provide diversification by not always moving in synch with one another, but they are also easily identified and mutually exclusive, making their usage in portfolio design more convenient. It's difficult to confuse a technology stock with a utility stock, for instance. On the contrary, it's not uncommon for a company to go from growth to value in a single quarter. A well-diversified portfolio should have exposure to as many sectors as possible, rather than concentrating too much funds in one or a few.

During the technology bubble, for example, the technology sector's returns greatly outperformed all other sectors' returns. During the eventual implosion of the bubble, this trend was completely inverted. For many portfolio managers, the decision to allocate to the technology sector throughout both markets had major career repercussions. Because of the importance of asset allocation, some portfolio managers have completely abandoned the effort and instead seek to stay neutral relative to benchmark sector allocation during the gulf war in 2003, the energy sector vastly outperformed all other sectors, badly hurting the sceptics of $60 per barrel oil. Assume that there is a drought, and that as a result, consumer demand in the country is projected to suffer a setback. Companies who are primarily focused on selling their goods and services to the domestic market are now likely to suffer as their near-term prospects have dimmed. On the contrary, a company that sells software services in the worldwide market, on the other hand, will be relatively unaffected by these trends. As a result, including both of these companies in a portfolio reduces the volatility of returns over time.

Sector risk is real and primary driver of market returns, therefore investors who want to understand and control their portfolios' risk/return situation must carefully manage their sector exposures, whether through individual stock positions or by keeping track of the sector weightings of active and indexed investments. An investor’s portfolio model can be categorised into three different type of portfolio profiles – aggressive portfolio, moderate portfolio and balanced portfolio based on the basic risk taking capacities of the investors. As discussed earlier there are three types of risk attitudes each resonate with the type of sectoral portfolio. A risk lover will tend to have an aggressive portfolio with a very high level of volatility. The expectation of returns from the investment is very high, the investor has an ability to tolerate high degree of fluctuations, is in a wealth accumulation stage and can wait for more than two decades to realise the money invested.

In case of risk adverse attitude of investors they prefer a moderate portfolio with moderately higher returns expectations from investment and ability to tolerate moderate degree of fluctuations in wealth accumulation stage of life. Whereas, in case of risk neutral attitude, investors prefer a balanced portfolio with an acceptable moderate level of risk and return.

A financial investor's primary goal, therefore, is to attain the best risk-return ratio possible. It can be accomplished by either maximising return while accepting a certain degree of risk or minimising risk while accepting a certain rate of return depending on their risk attitudes. Diversification thus has a huge impact on the portfolio's risk component in particular. It allows for a wide range of investments as well as a middle ground between market highs and lows and is widely regarded in the investment literature as a way to reduce non-systematic risk. A diverse portfolio does not focus on just one or two types of investments. Instead, it comprises some assets with high predicted returns and others that are more dependable. Returns are less volatile as a result of this. It permits investments to develop with the least amount of volatility possible.

However, there is a scarcity of specialised study in the domain of sectoral linkages and their implications for portfolio optimization. In particular, in the Indian setting, research is essentially non-existent. Using data from the Indian market, the current study tries to add to this specific area of portfolio optimization. The goal of the study is to ascertain some of the possible correlations that might exist between stock prices which will not only augment the understanding of the stock market but also play a vital role in portfolio management. This study has estimated the dynamics of association of stock market returns between industry sectors in India using the copula analysis.

Copula theorized by Skalr (1973) defines the dependencies among the set of financial variables by modeling the marginal distributions of each variable. In pursuit of Sklar's studies, we assume $X = (X_1,\ldots,X_d)$ is a random vector along with continuous marginal cumulative distributive functions $F_1 \ldots F_d$ and joint distribution H. The use of copula is justified since many popular economic variables have non-normal distributions. Deviations from normality include excess kurtosis (or fat tails) and skewness in univariate distributions. Asymmetric reliance has also been established as a deviation from multivariate normalcy in recent research. Asymmetric dependency occurs when two asset returns have a larger correlation during market downturns than during market upturns, as reported by Erb et. al. (1994), Longin & Solnik (2001). When confronted with such empirical data, it is difficult to remain unconvinced. There are two basic concerns that arise: The first is to propose more appealing alternative density definitions. The second problem is to discover more meaningful measures of reliance between two (or more) variables than linear correlation, because when the joint distribution of the variables of interest is not elliptical, the classic correlation coefficient fails to explain the dependence structure. The copula theory will be used in this work to solve these concerns.

The use of copula became very popular during the end of the 19th century especially with the publishing of two books on copulas which then became a standard reference. In 1997, Joe published a book in multivariate models majorly discussing copulas and the family of copulas. On similar grounds, Nelsen published his book on introduction to copulas in 1999 which was then reprinted with additions in 2006. Nevertheless, the concept of the copula in finance was made popular by Embrecht et.al (1999,2009).

Gradually, copula came to be used in various fields of study in financial economics, from risk management to pricing credit derivatives to making an investment decision, portfolio selection, and diversification. It also became extremely well known in studying the financial contagion among various countries as well. Many researchers and academicians in the fields of statistics, mathematics, and economics developed various forms of copula among which the most typical are elliptical copulas i.e., gaussian copulas derived from multivariate normal distributions and the Student t distribution. However, these copulas fail to capture the asymmetric dependence structures and hence other copulas such as Archimedean – Clayton, Gumbel, and Frank came to be known. Other copulas such as vine copulas and factor copulas have also been found to be superior in explaining the extreme values in the data and the lower as well as upper tail distribution. However, in this thesis, we concern ourselves with the Gaussian, Student t, and Archimedean copulas.

These copula models are used to investigate the Indian stock market's sectoral associations and the risk involved. The sector association and the risk involved is important to understand in order to form a portfolio with equivalent sectoral allocation. In theory, the total risk associated with an security or portfolio is the summation of systematic and unsystematic risk. However, the total risk can also be broken down into different sectors to capture the risk associated with each sectors. There may be different kind of sectors such as blue chip sectors, some with sluggish movements and some fast moving indexes. An examination of all these sectors, its association with the market index is utmost important in order to form an efficient portfolio.

The sectoral indices used in the study encompass a group of stocks that are representative of the entire market. These are from two major stock exchanges of India - National Stock Exchange and the Bombay Stock Exchange. Bombay stock exchange is the oldest stock exchange and provides an efficient, transparent market for trading in equities, currencies, debt instruments, derivatives, mutual funds. BSE’s popular equity index – the S&P BSE SENSEX – is India’s most widely tracked free-float market-weighted stock market benchmark index which comprises 30 well-established and financially sound companies. It constitutes around 7 major indices namely the broad (market capitalization) index, sector & industry index, thematic index, strategy index, sustainability index, the volatility index, and fixed income index. The broad market index is nothing but the benchmark index i.e., S&P BSE SENSEX.

National Stock Exchange, on the other hand, is a free-float market capitalization-weighted index established in 1992. It was the first dematerialized electronic exchange with fully automated screen-based electronic trading and 11th world largest stock exchange as of April 2018. It offers trading and investments in equity, derivatives, debt, equity derivatives, interest rate futures. Nifty50 is a benchmark broad-based stock market index of NSE which represents the weighted index of 50 Indian companies. Like the Bombay stock exchange, the national stock exchange also comprises five major indices namely, broad market index, sectoral index, thematic index, strategy index, and fixed income index. These stock market indices provide a historical perspective of the performance of various sectors that present investors with more insight into their investment decisions. Investors can use indexing as a method of choosing their stock investments if they do not possess knowledge about individual stocks.

Indices provide a barometer with which investors can compare the performance of their stock performance and can also ascertain how well their brokers/investment advisory firms are doing in managing their money. The most important use of indexing is forecasting. Market indices help to understand the sentiment of the market and how various sectors are affecting the market. This involves studying the historical values to identify trends/patterns to forecast trends in the future. They also help to understand the sentiment of the market and how various sectors are affecting the market. The volatility and the returns of the sector depict a fair idea about how the sector is performing.

1.9 RATIONALE

Academics, policymakers, and financial market participants all value the study of risk associated with financial assets for a variety of reasons. First, economic agents need to estimate financial market risk (volatility) considering that it is an indicator of risk exposure in their investments. Second, a fluctuating stock market is a big cause of worry for policymakers since it causes uncertainty, which has a detrimental impact on growth prospectus. According to new research, when markets are seen to be extremely unpredictable, they "may operate as a possible barrier to investing" (Poshakwale and Murinde, 2001, Raju & Ghosh, 2004). Third, consumer spending is reduced as a result of stock market volatility (Garner, 1988). Finally, stock return forecasting is essentially the same as volatility forecasting, which enables investors to secure safe positions or hedge against any potential loss. As can be seen, studying stock market volatility is crucial and may aid in the creation of economic policies as well as the formulation of rules and regulations connected to stock market volatility.

Volatility in the stock market has become a major source of concern for investors, regulators, and brokers since past decades. Consumer spending is hampered by stock return volatility, which also has an impact on company investment spending. Further severe volatility could undermine the financial system's smooth operation and result in structural or regulatory reforms. However, a rise in volatility is not an issue in and of itself. Volatility has risen as a result of underlying issues with basic dynamics affecting economic activities and expectations. In fact, the more rapidly and precisely prices reflect available knowledge, the more efficient securities pricing and thus resource allocation will be. Share prices fluctuate arbitrarily around their "intrinsic" values in a "efficient" market where prices fully reflect available information. Excessive speculation has resulted in excessive volatility in India's stock market, which has resulted in a number of crises. Excessive volatility in the Indian stock markets, without a doubt, damaged investor confidence in the early 1990s to some extent. Therefore the need to assess and predict stock market volatility has been recognised by exchange management, brokers, and investors alike.

The thesis aims to first investigate the fundamental nature, or characteristics, of the returns distribution of the benchmark index, as well as selected sectoral and thematic indices of the Bombay stock exchange and National stock exchange, namely heavy tails, absence of autocorrelation, slow decay of autocorrelation in absolute returns, volatility clustering, volatility persistence, leverage effect, gain/loss asymmetry and long memory. There has been no exclusive study on numerous stylized facts of the sectoral and theme indices on such a large scale, as will be seen in the review of literature chapter. This research aims to do the same, with the goal of assisting investors in constructing their portfolios based on the features of return distribution of various sectors.

Over and above, in finance, the pattern of inter dependence across financial markets is crucial for investors, policy makers and academicians to make informed decisions about where to allocate resources and make appropriate investment strategies. Conventional linear correlation models may lead to underestimation of risks of the financial data which is linked to market crash, hence it is important to employ models that account for non-linearity in the financial markets. Therefore the study employs elliptical and Archimedean copulas to better comprehend the relationship between the benchmark index and the sectoral/thematic indices. This approach aids in the interpretation of non-linear correlation of indices for risk management, portfolio management, and the pricing of securities, among other things. This type of research has never been done previously on such a broad scale, taking into account both of India's major exchange markets. This is the first attempt, which is supported by the review of literature chapter that follows.

1.10 CHAPTER SCHEME

The thesis is organised in nine chapters. Chapter two (Review of literature) critically examines the relevant literature on the subject of the present study. The chapter presents the survey of literature into four categories. The first category includes literature on the capital asset pricing model, the second category of literature includes various characteristics of stylized facts and methodology used to study those properties. The third category includes survey on sectoral allocation. Finally, the last part includes literature on copula analysis which is the methodology used to understand the dependence structure of the broad market, sectoral and thematic indices of the Indian stock market. The chapter also tries to identify gaps in literature and thereby also mentions the objectives of the study. Chapter three (Indian capital market: An overview) presents structure of the Indian financial market in brief followed by the history of BSE and NSE. Thereafter, it discusses in details the trend of prices of the benchmark indices of the BSE and NSE divided into different time frames.

Chapter four (Outline of few Indian Sectoral and Thematic indices) discusses in details the selected sectoral and thematic indices, its performance over a period of time, companies included in each sector and its returns. The methodology used in this study is discussed in full in Chapter Five (Research Methodology). The sample employed in this study, as well as the data sources, are described in this chapter. The chapter begins with a summary of the study's basic statistics, followed by unit root tests, ARCH, GARCH models, and copula models, which are used to evaluate stock market interaction effects.

Chapter six (Stock Market Risk: An Empirical Investigation) is organised into further three sections which are divided into three chapters. The sixth chapter presents descriptive statistics of the benchmark index, selected sectoral and thematic index of BSE and NSE. It also includes the price and returns trends for all of these followed by beta analysis and correlation analysis. The seventh chapter presents the GARCH model analysis for benchmark index, selected sectoral and thematic index of BSE and NSE. The analysis is carried out using five GARCH models – SGARCH, EGARCH, GJRGARCH, APARCH, and FIEGARCH. Finally, the eight chapter presents granger causality tests among the benchmark index, selected sectoral and thematic index of BSE and NSE followed by the models of copula analysis.

Finally, the summary of the study and policy recommendations for Indian stock markets are presented in Chapter Nine (Summary and Policy Recommendations), with the goal of minimising excessive volatility and comprehending intersectional links for the benefit of stock market participants. In addition, the chapter underscores the need for more research on stock market volatility.

Conclusion –

Thus for various reasons, researchers, policymakers, academicians, and financial market participants highly value the study of risks related to financial assets. The volatility in the stock market has grown to be a significant source of concern for investors, brokers and regulators. Hence the exchange management, brokers and investors have acknowledged the necessity to gauge and forecast stock market volatility. It is also imperative for them to decide where to devote resources and create effective investment strategies for which they must be aware of the pattern of interdependence across financial markets. To add to that it is all vital to establish and understand the relationship between the benchmark indices, i.e., BSE Sensex and NSE Nifty50 along with sectoral as well as thematic indices for which the study employs elliptical and archimedean copulas.