Journal of Accounting and Taxation Vol. 4(2), pp. 19-28, March 2012
Available online at http://www.academicjournals.org/JAT
DOI: 10.5897/JAT11.036
ISSN 2141-6664 ©2012 Academic Journals

*Review*

# The modern portfolio theory as an investment decision tool

**Iyiola Omisore[1], Munirat Yusuf[2]* and Nwufo Christopher .I.[3]**

[1]Senator, Federal Republic of Nigeria.
[2]Department of Business Administration, University of Abuja, Abuja, Nigeria.
[3]Department of Accounting, University of Abuja, Abuja, Nigeria.

Accepted 13 February, 2012

**This research paper is academic exposition into the modern portfolio theory (MPT) written with a primary objective of showing how it aids an investor to classify, estimate, and control both the kind and the amount of expected risk and return in an attempt to maximize portfolio expected return for a given amount of portfolio risk, or equivalently minimize risk for a given level of expected return. A methodology section is included which examined applicability of the theory to real time investment decisions relative to assumptions of the MPT. A fair critique of the MPT is carried out to determine inherent flaws of the theory while attempting to proffer areas of further improvement (for example, the post-modern portfolio theory [PMPT]). The paper is summarised to give a compressed view of the discourse upon which conclusions were drawn while referencing cited literature as employed in the course of the presentation.**

**Key words:** Assets, beta coefficient, diversification, expected returns, investment, portfolio, risk, uncertainty.

## INTRODUCTION

This paper presentation is an assessment of the modern portfolio theory as an investment decision tool. In the investment world, there exist different motives for investment. The most prominent among all is to earn a return on investment. However, selecting investments on the basis of returns alone is not sufficient. The fact that most investors invest their funds in more than one security suggests that there are other factors, besides return, and they must be considered. The investors not only like return but also dislike risk.

The financial market, despite the benefits and rewards, is a complexly volatile industry which requires critical analysis to adequately evaluate risks relative to returns to aid decisions as regards participation in the industry. Upon such premise, this research work is an academic insight into some analytics of the financial market. The presentation is an attempt to create foundation knowledge to understanding the workings of the financial market. Despite the span of the research, specific attention would be accorded to the Modern Portfolio Theory.

In the course of this discourse, some historical background to financial market analysis would be examined, related literature (to Modern Portfolio Theory) reviewed, its applications, pros and cons of the theory would equally be examined.

It is intended that this write-up would add to the existing pool of knowledge on the concept being investigated.

## LITERATURE REVIEW

Investment portfolio theories guide the way an individual investor or financial planner allocates money and other capital assets within an investing portfolio. An investing portfolio has long-term goals independent of a market's day-to-day fluctuations; because of these goals, investment portfolio theories aim to aid investors or

*Corresponding author. E-mail: drmrsyusuf@yahoo.com.

financial planners with tools to estimate the expected risk and return associated with investments.

Passive portfolio theories, on one hand, combine an investor's goals and temperament with financial actions. Passive theories propose minimal input from the investor; instead, passive strategies rely on diversification, buying many stocks in the same industry or market, to match the performance of a market index. Passive theories use market data and other available information to forecast investment performance.

Active Portfolio Theories come in three varieties. Active portfolios can either be patient, aggressive or conservative. Patient portfolios invest in established, stable companies that pay dividends and earn revenue despite economic conditions. Aggressive portfolios buy riskier stocks, those that are growing, in an attempt to maximize returns; because of the volatility to which this type of portfolio is exposed, it has a high turnover rate. As the name implies, conservative portfolios invest with an eye on yield and long-term stability.

In any financial market analysis, if the objective of the analysis involves determination of stocks to buy and at what price, there are two basic methodologies: Fundamental analysis, which maintains that markets may misprice a security in the short run but that the "correct" price will eventually be reached. Profits can be made by trading the mispriced security and then waiting for the market to recognize its "mistake" and re-price the security. Technical analysis, maintains that all information is reflected already in the stock price. Trends 'are your friend' and sentiment changes predate and predict trend changes. Investors' emotional responses to price movements lead to recognizable price chart patterns. Technical analysis does not care what the 'value' of a stock is. Their price predictions are only extrapolations from historical price patterns.

Fundamental analysis of a business involves analysing its financial statements and forexhealth, its management and competitive advantages, and its competitors and markets. When applied to futures and, it focuses on the overall state of the economy, interest rates, production, earnings, and management.

Fundamental analysis is performed on historical and present data, but with the goal of making financial forecasts. There are several possible objectives:

1. To conduct a company stock valuation and predict its probable price evolution
2. To make a projection on its business performance
3. To evaluate its management and make internal business decisions
4. To calculate its credit risk

While fundamental analysts examine earnings, dividends, new products, research and the like, technical analysts examine what investors fear or thought of these developments and whether or not investors have the Where withal to back up their opinions; these two concepts are called psych (psychology) and supply/ demand.

Technical analysts use market indicators of many sorts, some of which are mathematical transformations of price, often including up and down volume, advance/decline data and other inputs. These indicators are used to help assess whether an asset is trending, and if it is, the probability of its direction and of continuation. Also, relationships between price/volume indices and market indicators are sought. Examples include the relative strength index, and MACD. Other avenues of study include correlations between changes in options (implied volatility) and put/call ratios with price. Also, important are sentiment indicators such as put/call ratios, bull/bear ratios, short interest, implied volatility, etc.

There are many techniques in technical analysis. Adherents of different techniques (for example, Candlestick charting, Dow Theory, and Elliott Wave theory), may ignore other approaches, yet many financial traders combine elements from more than one technique. Some technical analysts use subjective judgment to decide which pattern(s) a particular instrument reflects at a given time and what the interpretation of that pattern should be. Others employ a strictly mechanical or systematic approach to pattern identification and interpretation.

Technical analysis is frequently contrasted with fundamental analysis; the study of economic factors that influence the way investors price financial markets. Technical analysis holds that prices already reflect all such trends before investors are aware of them. Uncovering those trends is what technical indicators are designed to do, imperfect as they may be. Fundamental indicators are subject to the same limitations, naturally. Some traders use technical or fundamental analysis exclusively, while others use both types to make trading decisions.

## THE MODERN PORTFOLIO THEORY (MPT)

Harry Markowitz 1991, an American economist in the 1950s developed a theory of "portfolio choice," which allows investors to analyse risk relative to their expected return. For this work Markowitz, a professor at Baruch College at the City University of New York, shared the 1990 Nobel Memorial Prize in Economic Sciences with William Sharpe and Merton Miller.

Markowitz’s theory is today known as the Modern Portfolio Theory, (MPT). The MPT is a theory of investment which attempts to maximize portfolio expected return for a given amount of portfolio risk, or equivalently minimize risk for a given level of expected return, by carefully choosing the proportions of various assets. Although the MPT is widely used in practice in the financial industry, in recent years, the basic assumptions

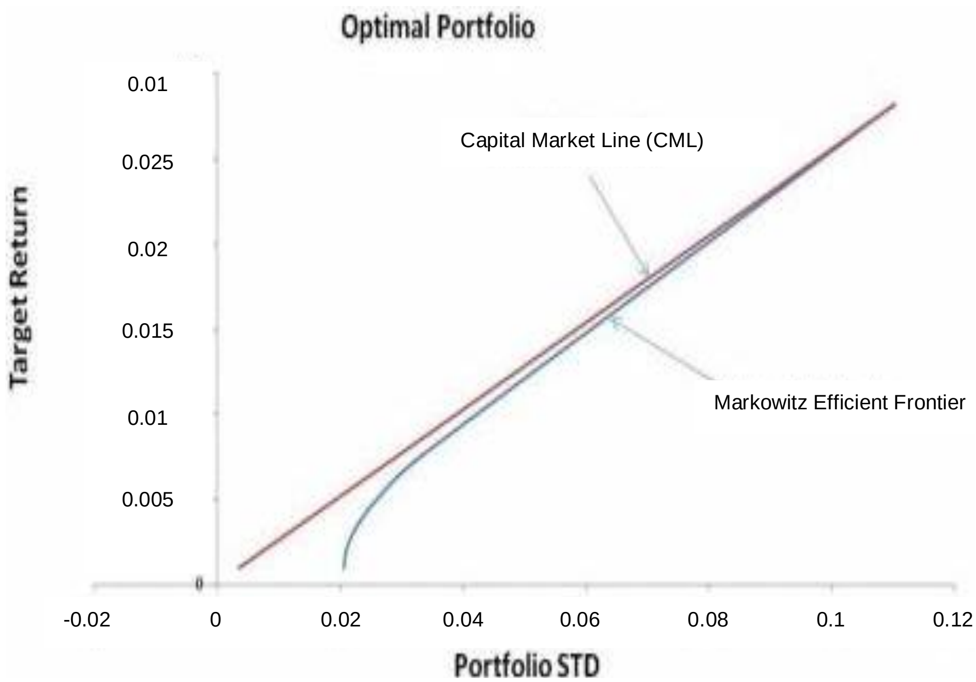


**Figure 1.** Markouwitz Modern Portfolio theory.

of the MPT have been widely challenged.

The Modern Portfolio Theory, an improvement upon traditional investment models, is an important advance in the mathematical modelling of finance. The theory encourages asset diversification to hedge against market risk as well as risk that is unique to a specific company.

The theory (MPT) is a sophisticated investment decision approach that aids an investor to classify, estimate, and control both the kind and the amount of expected risk and return; also called Portfolio Management Theory. Essential to the portfolio theory are its quantification of the relationship between risk and return and the assumption that investors must be compensated for assuming risk. Portfolio theory departs from traditional security analysis in shifting emphasis from analysing the characteristics of individual investments to determining the statistical relationships among the individual securities that comprise the overall portfolio (Edwin and Martins 1997).

The MPT mathematically formulates the concept of diversification in investing, with the aim of selecting a collection of investment assets that has collectively lower risk than any individual asset. The possibility of this can be seen intuitively because different types of assets often change in value in opposite ways. But diversification lowers risk even if assets' returns are not negatively correlated-indeed, even if they are positively correlated.

More technically, the MPT models an asset return as a normally distributed function (or more generally as an elliptically distributed random variable), define risk as the standard deviation of return, and models a portfolio as a weighted combination of assets so that the return of a portfolio is the weighted combination of the assets' returns. By combining different assets whose returns are not perfectly positively correlated, MPT seeks to reduce the total variance of the portfolio return. MPT also assumes that investors are rational and markets are efficient.

The fundamental concept behind the MPT is that assets in an investment portfolio should not be selected individually, each on their own merits. Rather, it is important to consider how each asset changes in price relative to how every other asset in the portfolio changes in price.

Investing is a trade-off between risk and expected return as shown in Figure 1. Generally, assets with higher expected returns are riskier (Taleb, 2007). For a given amount of risk, the MPT describes how to select a portfolio with the highest possible expected return. Or, for a given expected return, the MPT explains how to select a portfolio with the lowest possible risk (the targeted expected return cannot be more than the highest-returning available security, of course, unless negative holdings of assets are possible).

## Concept of risk and expected return

### *Return*

Return is the basic motivating force and the principal reward in any investment process. Returns may be defined in terms of realized return (that is, the return which has been earned) and expected return (that is, the return which the investor anticipates to earn over some future investment period). The expected return is a predicted or estimated return and may or may not occur. The realized returns in the past allow an investor to estimate cash inflows in terms of dividends, interest, bonus, capital gains, etc., available to the holder of the investment. The return can be measured as the total gain or loss to the holder over a given period of time and may be defined as a percentage return on the initial amount invested. With reference to investment in equity shares, return is consisting of the dividends and the capital gain or loss at the time of sale of these shares.

### *Risk*

Risk in investment analysis, is the unpredictability of future returns from an investment. The concept of risk may be defined as the possibility that the actual return may not be same as expected. In other words, risk refers to the chance that the actual outcome (return) from an investment will differ from an expected outcome. With reference to a firm, risk may be defined as the possibility that the actual outcome of a financial decision may not be same as estimated. The risk may be considered as a chance of variation in return. Investments having greater chances of variations are considered more risky than those with lesser chances of variations.

Risk should be differentiated from uncertainty; Risk is defined as a situation where the possibility of happening or non-happening of an event can be quantified and measured: while uncertainty is a situation where this possibility cannot be measured. Thus, risk is a situation where probabilities can be assigned to an event on the basis of facts and figures available regarding the decision. Uncertainty, on the other hand, is a situation where either the facts and figures are not available, or the probabilities cannot be assigned.

## Measurement of risk and the beta coefficient

No investor can predict with certainty whether the income from an investment will increase or decrease and by how much. Statistical measures can be used to make precise measurement of risk about the estimated returns, to gauge the extent to which the expected return and actual return are likely to differ. The expected return, standard deviation and variance of outcomes can be used to measure risk.

### *Beta coefficient*

There is another measure of risk known as β which measures the risk of one security/ portfolio relative to market risk. The market risk is represented by fluctuation in the market benchmark, that is, market index. Shares whose β factor is more than 1 are considered less risky. It may be noted that β is a measure of systematic risk which cannot be diversified away.

The total risk of an investment consists of two components: diversifiable (unsystematic) risk and non-diversifiable (systematic) risk. The relationship between total risk, diversifiable risk, and non-diversifiable risk can be expressed by the following equation:

Total risk = Diversifiable risk + Non diversifiable risk

## Assumptions of the modern portfolio theory

The framework of the MPT makes many assumptions about investors and markets. Some are explicit in MPT equations; such as the use of Normal distributions to model returns. Others are implicit, such as the neglect of taxes and transaction fees. None of these assumptions are entirely true, and each of them compromises the MPT to some degree. Predominant among the MPT assumptions is the efficient market theory.

### *The efficient market theory*

The efficient market theory is widely referred to as a hypothesis, and thus efficient market hypothesis (EMH) asserts that financial markets are "informationally efficient". That is, one cannot consistently achieve returns in excess of average market returns on a risk-adjusted basis, given the information available at the time the investment is made.

There are three major versions of the MPT hypothesis: "weak", "semi-strong", and "strong". The weak EMH asserts that prices of traded assets (for example, stocks, bonds, or property) already reflect all past publicly available information. The semi-strong *EMH* opines that prices reflect all publicly available information and that prices change to reflect new public information. The strong EMH additionally claims that prices instantly reflect even hidden or "insider" information. There is evidence for and against the weak and semi-strong EMHs, while there is powerful evidence against the strong EMH (Andrei, 2000).

Extensive researches have revealed signs of inefficiency in financial markets. Critics have blamed the belief in rational markets for much of the late-2000s global financial crisis. In response, proponents of the hypothesis have stated that market efficiency does not mean having no uncertainty about the future, rather the market efficiency is a simplification of the world which may not always hold true, and that the market is practically efficient for investment purposes for most individuals (Chambernan, 1983).

***Asset returns are (jointly) normally distributed random variables***

Despite this assumption, evidence from frequent observations shows that returns in equity and other markets are not normally distributed. Large swings (3 to 6 standard deviations from the mean) occur in the market far more frequently than the normal distribution assumption would predict. While the model can also be justified by assuming any return distribution which is jointly elliptical, all the joint elliptical distributions are symmetrical whereas asset returns empirically are not.

***Correlations between assets are fixed and constant forever***

Correlations depend on systemic relationships between the underlying assets, and change when these relationships change. During times of financial crisis, all assets tend to become positively correlated, because they all move (down) together. In other words, the MPT fails to function when investors are most in need of protection from risk.

***All investors aim to maximize economic utility***

Investors aim to maximize economic utility in order to make as much money as possible, regardless of any other considerations. This is a key assumption of the efficient market hypothesis, upon which the MPT relies.

***All investors are rational and risk-averse***

This is another assumption of the efficient market hypothesis, but we now know from behavioural economics that market participants are not rational. It does not allow for "herd behaviour" or investors who will accept lower returns for higher risk. Even gamblers clearly pay for risk, and it is possible that some stock traders will pay for risk as well.

***All investors have access to the same information at the same time***

This also comes from the efficient market hypothesis. In-fact, real markets contain information asymmetry, insider trading, and those who are simply better informed than others.

***Investors have an accurate conception of possible returns***

The probability beliefs of investors match the true distribution of returns. A different possibility is investors' expectations being biased, causing market prices to be informationally inefficient. This possibility is studied in the field of behavioural finance, which uses psychological assumptions to provide alternatives to the capital asset pricing model (Owen and Rabinovitch, 1983).

***There are no taxes or transaction costs***

Real financial products are subject both to taxes and transaction costs (such as broker fees), and taking these into account will alter the composition of the optimum portfolio. These assumptions can be relaxed with more complicated versions of the model.

***All investors are price takers***

Their actions do not influence prices. In reality, sufficiently large sales or purchases of individual assets can shift market prices for that asset and others (via cross-elasticity of demand). An investor may not even be able to assemble the theoretically optimal portfolio if the market moves too much while they are buying the required securities.

***Any investor can lend and borrow an unlimited amount at the risk free rate of interest.***

In reality, every investor has a credit limit.

***All securities can be divided into parcels of any size***

In reality, fractional shares usually cannot be bought or sold, and some assets have minimum order sizes.
More complex versions of the MPT take into account a more sophisticated model of the world (such as one with non-normal distributions and taxes) but all mathematical models of finance still rely on many unrealistic premises as stated previously.

## APPLICATION OF THE MODERN PORTFOLIO THEORY

The MPT assumes that investors are risk averse, meaning that given two portfolios that offer the same expected return, investors will prefer the less risky one. Thus, an investor will take on increased risk only if compensated by higher expected returns. Conversely, an investor who wants higher expected returns must accept more risk. The exact trade-off will be the same for all investors, but different investors will evaluate the trade-off differently based on individual risk aversion characteristics. The implication is that a rational investor will not invest in a portfolio if a second portfolio exists with a more favourable risk-expected return profile – that is, if for that level of risk an alternative portfolio exists which has better expected returns.

The MPT is therefore a form of diversification. Under certain assumptions and for specific quantitative definitions of risk and return, MPT explains how to find the best possible diversification strategy.

## Applying the theory

The Portfolio theory (MPT) approach has four basic procedures: Security valuation-describing a universe of assets in terms of expected return and expected risk; asset allocation decision- determining how assets are to be distributed among classes of investment, such as stocks or bonds; portfolio optimization-reconciling risk and return in selecting the securities to be included, such as determining which portfolio of stocks offers the best return for a given level of expected risk; and performance measurement-dividing each stock's performance (risk) into market-related (systematic) and industry/security-related (residual) classifications (Brodie, 2009).

### *Step one: Data collection*

Get historical data for all the selected equities. Determine the average weekly (or daily) returns and corresponding standard deviation in weekly returns. Find the correlation between selected assets.

### *Step two: Create a Markowitz efficient frontier*

The portfolio standard deviation is provided by the follow equation:

*σP = sqrt (∑square(wi). square(σi2) + ∑∑ wi .wj.Covij*

Construct different portfolios with given target returns (0.001, 0.002, etc.) and use the "solver" in excel to find weights such that the standard deviation for the portfolio (expressed previously) is minimized. Then, plot these portfolios with return on y-axis and risk or standard deviation on x-axis. The resulting envelope curve is called the "Markowitz efficient frontier". All the portfolios on this frontier are efficient in the sense that any portfolio beneath this line will not provide a better risk-return alternative (either the portfolio will have lower return for given risk or higher risk for given return) (Markowitz, 1959, 1952).

### *Step three: Create the market portfolio*

Market portfolio is defined as the portfolio with risky assets that provide highest expected return over risk-free rate per unit of risk for any available portfolio with risky assets. Or, a portfolio with the maximum Sharpe ratio.

### *Step four: Create the capital market line*

According to capital market theory, investors who allocate their capital between a riskless security and the risky portfolio (M) can expect a return equal to the risk-free rate plus compensation for the number of risk units they accept. In other words;

### *Step five: The optimal portfolio*

Finally, we are ready for our optimal portfolio. Optimal portfolio is represented by the point of tangency between the capital market line and the Markowitz efficient frontier.

The theory is a mathematical model that uses standard deviation of return as a proxy for risk, which is valid if asset returns are jointly normally distributed or otherwise elliptically distributed.

Under the model:

1. Portfolio return is the proportion-weighted combination of the constituent assets' returns.
2. Portfolio volatility is a function of the correlations $\rho_{ij}$ of the component assets, for all asset pairs (i, j).

**Expected return:**

$$\mathrm{E}(R_p) = \sum_i w_i \mathrm{E}(R_i)$$

Where $R_p$ is the return on the portfolio, $R_i$ is the return on asset i and $w_i$ is the weighting of component asset i (that is, the share of asset i in the portfolio).

**Portfolio return variance:**

$$\sigma_p^2 = \sum_i w_i^2 \sigma_i^2 + \sum_i \sum_{j \neq i} w_i w_j \sigma_i \sigma_j \rho_{ij},$$

Where $\rho_{ij}$ is the correlation coefficient between the returns on assets i and j.

Alternatively the expression can be written as:

$$\sigma_p^2 = \sum_i \sum_j w_i w_j \sigma_i \sigma_j \rho_{ij},$$

Where $\rho_{ij} = 1$ for $i = j$.

**Portfolio return volatility (standard deviation):**

$$\sigma_p = \sqrt{\sigma_p^2}$$

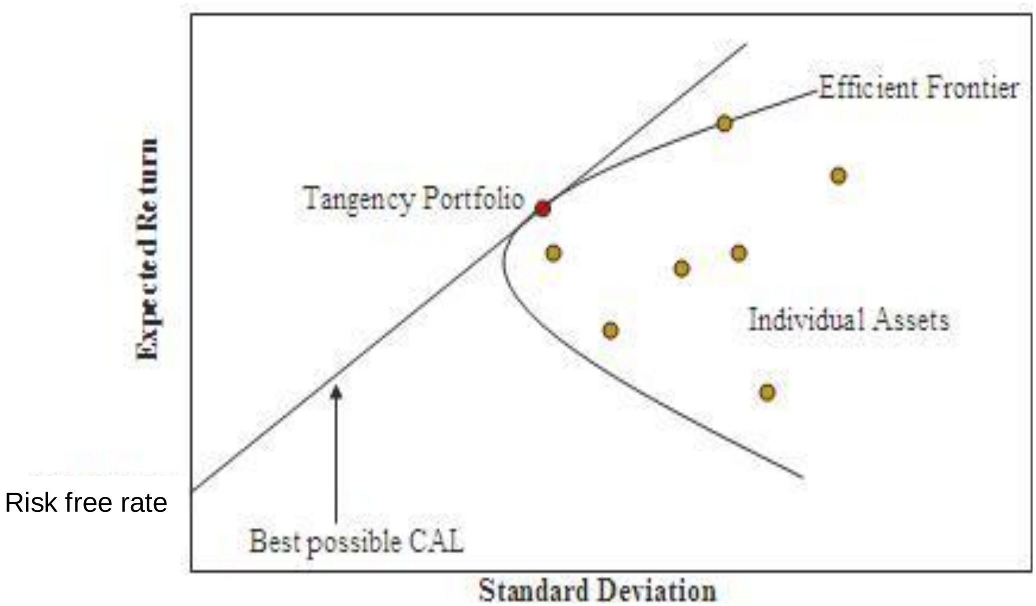


**Figure 2.** Efficient frontier. The hyperbola is sometimes referred to as the 'Markowitz Bullet', and is the efficient frontier if no risk-free asset is available. With a risk-free asset, the straight line is the efficient frontier.

**For a two asset portfolio, we have the following:**

Portfolio return:

$$\mathrm{E}(R_p) = w_A \mathrm{E}(R_A) + w_B \mathrm{E}(R_B) = w_A \mathrm{E}(R_A) + (1 - w_A)\mathrm{E}(R_B).$$

Portfolio variance:

$$\sigma_p^2 = w_A^2 \sigma_A^2 + w_B^2 \sigma_B^2 + 2 w_A w_B \sigma_A \sigma_B \rho_{AB}$$

**For a three asset portfolio, we have the following:**

Portfolio return:

$$w_A \mathrm{E}(R_A) + w_B \mathrm{E}(R_B) + w_C \mathrm{E}(R_C)$$

Portfolio variance:

$$\sigma_p^2 = w_A^2 \sigma_A^2 + w_B^2 \sigma_B^2 + w_C^2 \sigma_C^2 + 2 w_A w_B \sigma_A \sigma_B \rho_{AB} + 2 w_A w_C \sigma_A \sigma_C \rho_{AC} + 2 w_B w_C \sigma_B \sigma_C \rho_{BC}$$

## PRACTICAL APPLICATIONS OF THE THEORY IN INVESTMENT DECISION MAKING

### Diversification

An investor can reduce portfolio risk simply by holding combinations of instruments which are not perfectly positively correlated (correlation coefficient $-1 \leq \rho_{ij} < 1$). In other words, investors can reduce their exposure to individual asset risk by holding a diversified portfolio of assets. Diversification may allow for the same portfolio expected return with reduced risk.

If all the asset pairs have correlations of 0—they are perfectly uncorrelated—the portfolio's return variance is the sum over all assets of the square of the fraction held in the asset times the asset's return variance (and the portfolio standard deviation is the square root of this sum) (Koponen, 2003).

### The efficient frontier with no risk-free asset

As shown in Figure 2, every possible combination of the risky assets, without including any holdings of the risk-free asset, can be plotted in risk-expected return space, and the collection of all such possible portfolios defines a region in this space. The left boundary of this region is a hyperbola, and the upper edge of this region is the efficient frontier in the absence of a risk-free asset (sometimes called "the Markowitz bullet"). Combinations along this upper edge represent portfolios (including no holdings of the risk-free asset) for which there is lowest risk for a given level of expected return. Equivalently, a portfolio laying on the efficient frontier represents the combination offering the best possible expected return for given risk level (Kent et al., 2001).

Matrices are preferred for calculations of the efficient frontier. In matrix form, for a given "risk tolerance" $q \in [0, \infty)$, the efficient frontier is found by minimizing the following expression:

$w^T \Sigma w - q * R^T w$

Where, $w$ is a vector of portfolio weights and $_i \sum w_i = 1$ (The weights can be negative, which means investors can short a security); Σ is the covariance matrix for the returns on the assets in the portfolio; $q \geq 0$ is a "risk tolerance" factor, where 0 results in the portfolio with minimal risk and $\infty$ results in the portfolio infinitely far out on the frontier with both expected return and risk unbounded; and $R$ is a vector of expected returns. $w^T \Sigma w$ is the variance of portfolio return. $R^T w$ is the expected return on the portfolio.

The foregoing optimization finds the point on the frontier at which the inverse of the slope of the frontier would be $q$ if portfolio return variance instead of standard deviation were plotted horizontally. The frontier in its entirety is parametric on $q$.

Many software packages, including Microsoft Excel, MATLAB, Mathematical and R, provide optimization routines suitable for the foregoing problem.

An alternative approach to specifying the efficient frontier is to do so parametrically on expected portfolio return $R^T w$. This version of the problem requires that we minimize;

$$w^T \Sigma w$$

Subject to:

$$R^T w = \mu$$

For parameter μ. This problem is easily solved using a Lagrange Multiplier (Merton, 1972).

## Applications to project portfolios and other "non-financial" assets

The MPT is gradually being applied to portfolios of projects and other assets besides financial instruments. When applied beyond traditional financial portfolios, some fundamental differences between the different types of portfolios must be considered:

1. The assets in financial portfolios are, for practical purposes, continuously divisible while portfolios of projects are "lumpy". For example, while we can compute that the optimal portfolio position for 3 stocks is, say, 47, 30 and 23%, the optimal position for a project portfolio may not allow us to simply change the amount spent on a project. Projects might be all or nothing or, at least, have logical units that cannot be separated. A portfolio optimization method would have to take the discrete nature of projects into account.
2. The assets of financial portfolios are liquid; they can be assessed or re-assessed at any point in time. But opportunities for launching new projects may be limited and may occur in limited windows of time. Projects that have already been initiated cannot be abandoned without the loss of the sunk costs (that is, there is little or no recovery/salvage value of a half-complete project).

However, that neither of these cited differences necessarily eliminates the possibility of using the MPT and such portfolios. They simply indicate the need to run the optimization with an additional set of mathematically-expressed constraints that would not normally apply to financial portfolios.

Furthermore, some of the simplest elements of the modern portfolio theory are applicable to virtually any kind of portfolio. The concept of capturing the risk tolerance of an investor by documenting how much risk is acceptable for a given return may be applied to a variety of decision analysis problems. MPT uses historical variance as a measure of risk, but portfolios of assets like major projects do not have a well-defined "historical variance". In this case, the MPT investment boundary can be expressed in more general terms like "chance of a return on investment (ROI) less than cost of capital" or "chance of losing more than half of the investment". When risk is put in terms of uncertainty about forecasts and possible losses then the concept is transferable to various types of investment.

## Application to other disciplines

As far back as the early 1970s, concepts from modern portfolio theory gained relevance in the field of regional science. In a series of seminal works, researchers, such as Michael Conroy, modelled the labour force in an economy using portfolio-theoretic methods to examine growth and variability in the labour force. This was followed by an extensive literature on the relationship between economic growth and volatility.

More recently, modern portfolio theory has been used to model the self-concept in social psychology. When the self attributes comprising the self-concept constitute a well-diversified portfolio, then psychological outcomes at the level of the individual such as mood and self-esteem should be more stable than when the self-concept is undiversified. This prediction has been confirmed in studies involving human subjects.

Recently, the theory has been applied to modelling the uncertainty and correlation between documents in information retrieval (Chandra and Shadel, 2007).

## CRITICISM OF THE THEORY

Despite its theoretical relevance, the MPT has been highly criticised; its simplistic assumptions being a predominant bias. Critics question its viability as an investment strategy, because its model of financial markets does not match the real world in many ways. In recent years, basic underlying assumptions of the MPT have been grossly challenged by fields such as the behavioural economics.

Efforts to translate the theoretical foundation of the theory into a viable portfolio construction algorithm have been plagued by technical difficulties stemming from the instability of the original optimization problem with respect to available data. Recent research shows that instabilities of this type disappear when a regularizing constraint or penalty term is incorporated in the optimization procedure.

### The theory does not really model the market

The risk, return, and correlation measures used by MPT are based on expected (forecast) values, which means that they are mathematical statements about the future (the expected value of returns is explicit in such equations, and implicit in the definitions of variance and covariance). In practice, investors must substitute predictions based on historical measurements of asset return and volatility for these values in the equations. Very often, such expected values fail to take account of new circumstances which did not exist when the historical data were generated.

More fundamentally, investors are stuck with estimating key parameters from past market data because the MPT attempts to model risk in terms of the likelihood of losses, but says nothing about why those losses might occur. The risk measurements used are probabilistic in nature, not structural. This is a major difference as compared to many engineering approaches to risk management.

### The Theory does not consider personal, environmental, strategic, or social dimensions of investment decisions

It only attempts to maximize risk-adjusted returns, without regard to other consequences. In a narrow sense, its complete reliance on asset prices makes it vulnerable to all the standard market failures such as those arising from information asymmetry, externalities, and public goods. It also rewards corporate fraud and dishonest accounting. More broadly, a firm may have strategic or social goals that shape its investment decisions, and an individual investor might have personal goals. In either case, information other than historical returns (as suggested by the MPT) is relevant.

### The MPT does not take cognisance of its own effect on asset prices

Diversification eliminates non-systematic risk, but, at the cost of increasing the systematic risk. Diversification forces the portfolio manager to invest in assets without analysing their fundamentals; solely for the benefit of eliminating the portfolio's non-systematic risk (the capital asset pricing investment in all available assets) (Chandra, 2003). This artificially increased demand pushes up the price of assets that, when analysed individually, would be of little fundamental value. The result is that the whole portfolio becomes more expensive and, as a result, the probability of a positive return decreases (that is, the risk of the portfolio increases).

The legitimacy of the modern portfolio theory has been challenged by financial analysts who often cite Warren Buffett as a rule breaker. Warren Buffett, a major financial market referral with successful financial takeovers in his resume, is not a typical investor. Unlike the average mutual fund manager, Buffet often buys companies and then manages them. He provides them with economies of scale, lower cost of capital and the benefits of his managerial wisdom. And when he takes large portions in companies, he often gets a board seat. So perhaps his great returns are more a result of his managerial skills than his investment skills, or some combination of both. This, obviously, is not congruent with the line of thought of MPT proponents (Sabbadini, 2010).

## CONCLUSION

This paper presentation sought to review the relevance of the modern portfolio theory as an investment portfolio tool in portfolio decision making. In the course of the research, the relevance and applicability of the MPT was reviewed, however, it was also established that many inherent flaws of the theory have marred the efficacy of the theory. Among other things, its simplistic assumptions and direct correlation of risks and returns were identified as significant flaws.

Despite the limitations of the theory, it is still widely accepted and further research is being carried out on its principles. The post modern portfolio theory is a significant advancement of the theory. Post-modern portfolio theory encourages far greater diversification in an investment portfolio than does the MPT. By utilizing the alpha coefficient and the beta coefficient, each of which gauge an investment's performance, investors can engineer a portfolio's risk and returns to coincide with investment objectives. The alpha coefficient measures an investment's performance relative to its risk; the beta coefficient measures an investment's return relative to the market as a whole. The post-modern portfolio theory (PMPT) separates alpha- and beta-generated revenue, and then considers each individually to maximize their performance. The PMPT is more adaptable to the individual investor and can gauge risk relative to the investor's minimum acceptable return (MAR) for an asset.

## REFERENCES

Andrei S (2000). Inefficient Markets: An Introduction to Behavioral Finance. Clarendon Lectures in Economics, p. 145.

Brodie DM, Daubechies G, Loris (2009). Sparse and stable Markowitz portfolios. Proc. Natl. Acad. Sci., pp. 106.

Chambernan G (1983). A characterization of the distributions that imply mean-variance utility functions, J. Econ. Theory, 29: 185-201.

Chandra S (2003). Regional Economy Size and the Growth-Instability Frontier: Evidence from Europe". J. Reg. Sci., 43(1): 95-122. doi:10.1111/1467-9787.00291.

Chandra S, Shadel WG (2007). Crossing disciplinary boundaries: Applying financial portfolio theory to model the organization of the self-concept. J. Res. Personal., 41(2): 346-373. doi:10.1016/j.jrp.2006.04.007.

Edwin JE, Martin JG (1997). Modern portfolio theory, 1950 to date. J. Bank. Fin., 21: 1743-1759.

Harry MM (1991). Autobiography, The Nobel Prizes 1990, Editor Tore Frangsmyr, [Nobel Foundation], Stockholm, pp. 56-70.

Kent D, Daniel DH, Avanidhar S (2001). Overconfidence Arbitrage, and Equilibrium Asset Pricing. J. F., 56(3): 921-965.

Koponen TM (2003). Commodities in action: measuring embeddedness and imposing values. Sociol. Rev., 50(4): 543-569.

Markowitz HM (1952). Portfolio Selection. J. Fin., pp. 120-131

Markowitz HM (1959). Portfolio Selection: Efficient Diversification of Investments. New York: John Wiley Sons, pp. 95-112. (reprinted by Yale University Press, 1970, ISBN 978-0-300-01372-6; 2nd ed. Basil Blackwell, 1991, ISBN 978-1-55786-108-5)

Merton R (1972). An analytic derivation of the efficient portfolio frontier, J. Fin. Quant. Anal., September, 7: 1851-1872.

Owen J, Rabinovitch R (1983). On the class of elliptical distributions and their applications to the theory of portfolio choice, J. Fin. 38: 745-752.

Sabbadini T (2010). Manufacturing Portfolio Theory. International Institute for Advanced Studies in Systems Research and Cybernetics. pp.120-160.

Taleb NN (2007). The Black Swan: The Impact of the Highly Improbable, Random House, pp. 80-120.