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Post-modern portfolio theory supports diversification in an investment portfolio to measure investment's performance

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Abstract

This study looks at the Post-Modern Portfolio Theory that maintains greater diversification in an investment portfolio by using the alpha and the beta coefficient to measure investment performance. Post-Modern Portfolio Theory appreciates that investment risk should be tied to each investor's goals and the outcome of this goal did not symbolize economic of the financial risk. Post-Modern Portfolio Theory's downside measure generated a noticeable distinction between downside and upside volatility. Brian M. Rom & Kathleen W. Ferguson, 1994, indicated that in post-Modern Portfolio Theory, only volatility below the investor's target return incurred risk, all returns above this target produced 'ambiguity', which was nothing more than riskless chance for unexpected returns.

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1 Introduction

Nowadays, many investors are using some theory or another in making investment decisions. The prelude of Post-Modern Portfolio Theory had presented a structure that helps to recognize the enviable for upside and downside volatility. Bean N (2009) indicated that the traditional Modern Portfolio Theory was quite often referred to as Mean Variance Optimization.

Cheng P. (2001) mentioned that there are some significant limitations in the Modern Portfolio Theory which had been noted. This happens if the unsatisfied aspects of Modern Portfolio Theory had some assumption such as “Mean Variance Portfolio Optimization is inadequate when asset returns are skewed” and “Investor risk aversion is ignored.” Sing T F and Ong. SE, (2000) mentioned that it can be said that the results of Modern Portfolio Theory provide are limited by the measure of returns and risks, which means that it does not always stand for the realities of investment markets.

Cynthia Harrington (2002) indicated that with the advancement in portfolio, financial theory and as well as the increase in electronic computing has brought about the reduction in the limitation of the Modern Portfolio Theory. Hence, the expanded new risk - return paradigm is also known as the Post-Modern Portfolio Theory (PMPT).

According to Vern Sumnicht (2008), Post-Modern Portfolio Theory is a modification of the Modern Portfolio Theory in order to maximize usefulness of the theory for supporting advisors in the attempt to increase investment results for their investors. Post-Modern portfolio Theory helps the investor in considering

how a risky asset ought to be priced and how normal investors should use diversification to maximize their portfolios.

2 Background study

According to Vern Sumnicht (2008), fifty years ago, the authors of Modern Portfolio Theory had understood that there were limitations to their work such as to define and compute risk. The original Modern Portfolio Theory did not use a downside movement measure of risk using computers to calculate mathematic functions as these calculations were impossible to be done manually.

Pete Swisher (2005) related in 1959 that Harry Markowitz was the "father of Modern Portfolio Theory" to publish Portfolio Selection, indicated that investors expected to be compensated for taking additional risk, and that an infinite number of resourceful portfolios existed along a curve defined by three variables: standard deviation, correlation coefficient, and return. Fishburn P.C. (1977) indicated that the efficient-frontier curve consisted of portfolios with the maximum return will be given with increased risk taken by the investor or lesser returns with reduced risk. Harry Markowitz (1959) formalized what other investors already knew, which was that profitability corresponded to the level of risk. As he was the first person to mathematically establish that the total risk of a portfolio was inferior to the sum of the individual risk for each element of a portfolio. Cynthia Harrington, CFA (March 7, 2002) mentioned that by taking periodical performances as random variables, it could be possible to calculate performance expectations, standard deviation and correlations.

In another study by Vern Sumnicht (2008) which indicated that the work on Modern Portfolio Theory won Markowitz his share of a Nobel Prize. In Chopra, Vijay K; Ziemba, William T (1993), showed that it was an essential assessment of errors on performance expectations that had an impact on the setting up of

portfolios. The assessment errors on variances and co-variances clearly had less impact. The efforts of the portfolio advisors had carried out a good assessment of the performance. In the same year of 1993, Brian M. Rom and Kathleen W. Ferguson published an article on the Post Modern Theory of portfolio in the "The Journal of Investing". Subsequently, with the introduction of the Sortino ratio, of risk loss, of the MAR (Minimum Asset Return) and other parameters gave way to new avenues for refining of the average-variance model.

2.1 Research objectives

1. This paper examines the principles of Post Modern Portfolio theory which supports the diversification in an investment portfolio by utilizing the alpha and beta coefficient to measure investment’s performance.
2. The review the improvements to Modern Portfolio Theory (MPT) in order to increase the theory’s usefulness for financial advisors who want their portfolio optimization endeavour to expand their investment outcome for investors.
3. To explore the expected returns, the classification of risk, diversification, and investor costs.

2.2 Literature review

In a special way the PMR theory seeks to maximize absolute return and minimize risk, the Post-Modern Portfolio Theory gives investors fresh prospects to investors that were not given by the traditional Modern Portfolio Theory. Olivier Hoang, (2004), indicated that the Post-Modern Portfolio Theory provided managers some leeway and flexibility in their decision making in asset classes without resorting to alternative investments. As it could subsequently cover most of the portfolio's assets and notably contributed to its total return. Kaplan, P and L.

Siegel (1994) mentioned that the Post Modern Portfolio theory was based on essential assumptions such as:-

- No transaction costs in buying, selling securities, no brokerage, no spread and no taxes and only "risk" was important to be considered when buying securities.
- Any sensible investors can make a decision on any security as the market and the availability of funds was unlimited.
- Investors who were sensible and well aware of all risk entailed would take a stand based on the level of risk and returns for accepting greater volatility.
- All investors had the same knowledge of risk-return relationships over the same time horizon and regardless of the volatility.
- All investors were concerned about how to manage and measure risk and they wanted information as to when to buy or sell based on a similar assessment of the investment and wanted the same returns from their investment portfolio.
- Investor normally wants to control risk by diversification of their portfolio.
- They also have the knowledge of assets could be bought and sold in the market and similarly, all investors can also lend or borrow at the same risk-free rate and sell without any restrictions.

2.3 Features of Post Modern Portfolio theory

In the Post Modern Portfolio theory it is most often normal that the most likely outcome was not necessarily the anticipated one. Oliver Hoang (2004) indicated that the Post-Modern Portfolio Theory explains that the volatility and the tracking error were not full-blown risk measures. In the end, the Post-Modern Portfolio Theory led to review of the international diversification notion principle of the currency risk, which made allocations manageable.

Discussions on the correctness of the application of the result among researchers such as Brian M. Rom and Kathleen W. Ferguson (1994), who had indicated that Since Harry Markowitz had introduced the structure of what is known as Modern Portfolio Theory (MPT)." Markowitz (1952) had indicated that this has helped investors to make investment decision using the mathematical concept of diversification in investing; the target was to select a portfolio of investment asset that had collectively lowered risk of any other individual asset.

Pete Swisher & Gregory W. Kasten (2005) indicated that today there were many toolkits that is included in the data such as r^2, beta, alpha, and the Sharpe ratio, are necessary in an investment decision analysis. Yet each of these measures relied on standard deviation were flawed where else the PMPT had offered the best substitute. This is shown below in a study which was conducted by Pete Swisher & Gregory W. Kasten (2005).

Table 2: PMT versus MPT Measures

Purpose	Risk Measure	Outperformance vs Benchmark	Risk Compared to Benchmark s' risk	Excess Return per Unit of Risk
MPT Version	Standard Deviation	Alpha	Beta	Sharpe Ratio
PMPT version	Downside risk (DR)	Omega Excess; Also Excess Return (Above MAR)	DR vs Benchmark DR (Though various Betas could be calculated using DR Components)	Sortina Ratio (Excess Return DR)

Source: Pete Swisher & Gregory W. Kasten (2005) Contributions to Post-Modern Portfolio Theory, J F P.

Many researchers had found that there are some significant limitations to the traditional Modern Portfolio Theory calculation. Sometimes, the mean-variance

approach can be seen to lead to unsatisfactory predictions of behavior. To this Markowitz suggested that a new model based on the semi-variance would be desirable to overcome these computational problems. However, he had also based his analysis on the variance and standard deviation. Nolan Bean,(2009) indicated that Modern Portfolio Theory was no a good measure of risk and return as it not show the reality of an investment market. Sortino, F. and S. Satchell, (2001), mentioned that this theory had overcome these problems and it was now known as Post-Modern Portfolio Theory.

Two of the most important enhancements offered by the Post-Modern Portfolio Theory formulation were the downside risk and asymmetrical return distributions as indicated by Brian M. Rom and Kathleen W. Ferguson, (1994). Post-Modern Portfolio Theory provided analysts with flexibility and accuracy in creating efficient portfolios which was not achievable under Markowitz mean-variance methodology. Brian M. Rom and Kathleen W. Ferguson, (1994) used some examples of policy decisions using two methods which illustrated how Mean Variance Optimization could produce illogical and counter-intuitive results and the potentiality of Post-Modern Portfolio Theory to overcome these problems. According to Vern Sumnicht, (2008) he mentioned that three variables had given rise to the framework of the Modern Portfolio Theory they are firstly, advances in computer technology, next the study of portfolio management and finally, behavioral science. These advances in investment management are challenged by others. It is required to create an asset allocation models which was big enough to deliberate extra capital as well as economic factors, asset allocation and re-balancing decisions.

Post-Modern Portfolio Theory had given a great contribution to the applications and technologies that can meliorate investment results and transferred the Modern Portfolio Theory principle to a new level of usefulness (Vern Sumnicht, 2008). All of these improvements were available for the investment advisors to apply in order to assist investors to obtain their investment objectives.

2.4 Total Variability of Return

By using Modern Portfolio theory, the risk was defined as the total variability of returns around the mean return. It handled all uncertainty the same. “Risk was not symmetrical—it was severely skewed, with the greatest concern was that it was downside” as indicated by Brian M. Rom &Kathleen W. Ferguson, (1994). The importance of skew lied in the fact that non-normal return series was its true risk which was distorted by Modern Portfolio Theory measure.

In another study by Harlow, W.V.(1991) he mentioned that with the introduction of the Post-Modern Portfolio Theory, which was able to capture more accurate information towards the returns under consideration. “PMPT recognized that investment risk should be tied to each investor’s specific goals and that any outcomes above this goal did not represent economic or financial risk.” (Brian M. Rom & Kathleen W. Ferguson, 1994).

In the theory of Post Modern Portfolio, the investor’s target rate of return was called the Minimum Acceptable Return. “Minimum acceptable return, represents the rate of return that must be earned, to achieve some important financial objective” (Brian M. Rom & Kathleen W. Ferguson, 1994). Because Minimum Acceptable Return is investor specific, it meant that there were an infinite number of efficient frontiers where one for each minimum acceptable returns. This meant that Post-Modern Portfolio Theory was more accurately reflected the reality that there had different aims and an inclination for risk in different investors.

2.5 Downside Risk and Mean-Variance Optimization

Grootveld & Hallerbach, (1999) had indicated that the overall design behind the downside risk is that the left hand side of a return distribution involves risk while the right hand side holds better outlay opportunities. Riddles Neil, (2001)

had mentioned that the main advantage of downside risk over standard deviation is that it accommodates different views of risk.

The first study of the concept of portfolio optimization relates to Downside Risk instead of the traditional Mean- variance optimization is introduced to the field of real estate research by Sivitanides (1998) and Sing an Ong (2000). Sivitanides had analyzed the return to a Downside Risk profile of portfolios based on the four property types, which is office, retail, Research and development, and warehouse direct real estate investments in investments. While Sing and Ong (2000) had examined the mixed asset portfolio allocations which contained stocks, bonds, and direct real estate. The study showed how investor risk aversion could be incorporated with the downside risk asset optimization model. These researches mainly focused on the comparison between portfolios appreciated by the Mean-variance or Downside Risk framework.

In another study conducted by Ping Cheng (2001) which had also examined Mean-Variance Optimization as well as Downside Risk Optimization explained superior portfolios which had the best tradeoff within their own risk-return spaces. This measurement was determined among these two approaches, which created a portfolio that provided higher returns. To compare these two distinct approaches, the Cheng P (2001), used bootstrapping procedures which showed that Downside Risk Optimization produced the portfolio combination which was more realistic and accurate to the practice of institutional investors in terms of real estate allocation. Consequently, the outcome from the Downside Risk Optimization method was in demand to those investors who welcomed every bit of downside risk deduction (Cheng.P, 2001).

The concept of downside risk used in Post-Modern Portfolio Theory had been proposed as an alternative approach used in the traditional Mean Variance Optimization used in Modern Portfolio Theory. According to Peter Swisher (2005), he indicated that the traditional Mean variance optimization endeavored to response to these questions using standard deviation. Whereas, downside risk

optimization had disparity in the definition of risk. “Standard deviation had some limitations and was not the best replacement of risk.” As indicated by Antto Alenius, (2008). “However standard deviation assumed the returns of the fund to be normally distributed, which had been misleading when interpreting the result.” as mentioned by Eling and Schuhmacher, (2007). Instead of using standard deviation, Downside Risk Optimization was used in his estimation. In another study by Pete Swisher (2005) he had mentioned that Standard deviation lead to inaccurate results when used as a risk proxy, whereas variance downside risk capture more closely; even if volatility were a perfect representation of risk, it’s still would not work perfectly because financial asset return do not follow a normal distribution; when we put Downside Risk Optimization and Mean-Variance Optimization head to head and compare portfolio, Downside Risk Optimization wins. Specifically Downside Risk Optimization outputs make intuitive sense well Mean-Variance Optimization outputs often do not, and Mean-Variance Optimization outputs frequently reach risk conclusions opposite those of Downside Risk Optimization.” Downside risk is efficient than standard deviation that used in mean variance optimization because it supply different views of risk (Riddles Neil, 2001).

According to Anton Abdulbasah Kamil and Khalipah Ibrahim (2005), “The popularity of downside risk in Post-Modern Portfolio Theory amongst investors had grown and mean-return-downside risk portfolio range of models seemed to have subjugated the mean-variance approach”. Sing. T F and Ong S E. (2000) indicated that the model had success because it separated return fluctuation into downside risk and upside potential. Because of in mean-variance model, upside potential is same as downside risk, so this leads to what Markowitz proposed that the downside risk measured semi-variance to replace variance as the risk measure. Anton had compared the returns of the optimal portfolio to the performance of the model with the other models. In the comparison result, it shows that the

performance of the model with Downside Risk Optimization model is efficient than Mean-Variance Optimization model.

According to Ang, Chen and Xing (2005) had analyzed that downside risks premium in the cross section of stock returns. The result showed that cross section of stock returns reflected a premium for downside risks. “Stocks that co-varied strongly with the market, conditional on market declines had high average return.” as mentioned by Ang, Chen & Xing, (2005).

2.6 Management of Returns and Risks

Ray Dalio, founder of Bridgewater Associates (2005) “The traditional application of Modern Portfolio Theory first amalgamated the various asset classes derived based on their expected returns, risks and correlation, and ones the asset allocation mix is determined identify the optimal risk/reward relationship. By contrast, Post-Modern Portfolio Theory differs in three key ways: first, returns from alpha and beta are separated; second, the sized are altered to more desirable levels; finally, far more diversified portfolios of each are derived.”

In study conducted by Leibowitz, M.L., and T.C. Langeteig.(1998) showed that Post-Modern Portfolio Theory portfolio not only focused on risks and returns but also investors objectives. Sortino F and S Satchell (2001), had discussed the three basic building blocks: the risk free returns, returns in alpha, and returns in beta and described how they can fit together produced a more diversified beta and alpha portfolios calibrated to one’s targeted returns, where investors can dramatically improved their investment objectives as mentioned by Sortino, F. and H. Forsey (1996), Ray Dalio, (2005).

3 Findings and discussions

From the literature review, it can be concluded that Post-Modern Portfolio Theory provided the investors with an accurate form of efficient portfolio that is unavailable under the Traditional Modern Portfolio theory which was introduced by Markowitz.

3.1 Downside risk Optimization

Post-Modern Portfolio Theory presented a new method of asset allocation that optimizes portfolio based on returns versus downside risk called Downside Risk Optimization instead of Mean-Variance optimization.

By using the downside risk formula these three elements had been established.

1. Downside frequency - The frequency, expressed as a percentage, of returns below Minimal

Acceptable Return.

2. Average downside deviation - The average size of the deviation below the Minimal

Acceptable Return.

3. Downside magnitude - The worst-case scenario, represented by the return below Minimal

Acceptable Return at the 99^{th} percentile.

Source : Pete Swisher, (2005).

These three statistical methods had been combined into a single downside risk measure. Each of these measures is defined with reference to an investor-specific minimal acceptable return as shown by Pete Swisher, (2005). The result was expressed as a percentage, much like standard deviation, and the values themselves might even be similar.

$$\mathrm{LPM}_n = \int_{-\infty}^{T} (T - R)^n \, df(R)$$

T = the annual target return, originally termed the minimum acceptable return, or MAR.[2]

R = the random variable representing the return for the distribution of annual returns $f(R)$

n = degree of the moment

It can be said that when n =2, LMP_2 is called semi-variance. For the square root of semi-variance is known as semi-deviation. Downside risk is an estimation of a security's potential to endure a decline in price when the market conditions get worse. It can be an estimation of the potential losses that may occurs on investment or stocks (Cheng.P, 2001).

3.1.1 There are several ways to view downside risk

View the downside risk is the annualized standard deviation of returns below the target.

Another is the square root of the probability-weighted squared below-target returns. The squaring of the below-target returns has the effect of penalizing failures at an exponential rate.

There are two formulas for Downside risk

Continuous form $\sqrt{\int_{-\infty}^{t} (t - r)^n \, df(r)}$

t = annual target return

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[2] Source: Pete Swisher, (2005)

r = random variable representing the return for the distribution of annual returns $f(r)$.

$f(r)$ = normal or three parameter lognormal distribution.

Discrete form $3.464\sqrt{\frac{E(t-r)^n}{n}}$

3.464 = the square roof of 12, the factor used to annualize the monthly downside risk.

E = mathematical Expectation operator

t = monthly target return

r = random variable representing operator monthly return

n = total number of monthly returns observed

The continuous form is more preferable because it permits the calculation to be made using annual returns. It helps investor to specify their investment target. While for discrete formulas, it requires monthly returns and in return investors to change the annual target into a monthly targets as indicated by Frank A. Sortino & Stephen E. Satchell, (2001).

Forsey. H; (2001) showed that downside Risk Optimization model in Post-Modern Portfolio Theory could be said to be more efficient than Variance Optimization in Modern Portfolio Theory. It is because Downside Risk Optimization produces the portfolio combination which is more pragmatic and accurate to corporate investors in terms of real estate distribution. On measuring Variance Optimization portfolio, Downside Risk Optimization method was reliable with investor's risk conceptions that encouraged investor who feared downside risks. Not only that, it helps to develop the portfolio performance with higher median returns as explained by Cheng.P, (2001).

3.1.2 Volatility skewness

Many researchers had stated that not all the distribution is normal. In Modern Portfolio Theory normal distribution is carried out. In using normal distribution to model the pattern of investment returns, it creates the investment that result with more upside than downside returns which looks as if it is more risky than they actually are, and vice versa for returns with more a prevalent downside returns. It can be concluded that by using the Traditional Modern Portfolio Theory for measuring the portfolios it often distorts the investment reality.

Fortunately, with the introduction of hedging and derivative strategies, asymmetrical are designed and used in Post-Modern Portfolio Theory. Volatility is another concept that was introduced by Post-Modern Portfolio Theory enthusiasts. Vishal Mewasingh (2006) indicated that Post-Modern Portfolio Theory was able to capture significantly more true information. It examines the ratio of a allotment's percentage of total variance from returns above the mean, to the percentage of the allotment's total variance from returns below the mean as indicated by Brian M. Rom and Kathleen W. Ferguson,(1994).

Table 3: Skewness of Major Asset Classes and Inflation

Asset	Periods Ending 31 December 1982		
	10 Yrs	20 Yrs	30 Yrs
Large-Cap Stocks	1.80	1.23	0.89
Small-Cap Stocks	1.07	1.22	1.14
Foreign Stocks	0.92	1.10	NA
Bonds	0.83	0.94	0.97
Cash	0.64	1.25	1.11
Inflation	0.82	1.35	3.03

Source: Brian M. Rom, (1994).

Table 3 shows, the several asset classes over different periods and skewness ratio as indicated by Brian M. Rom and Kathleen W. Ferguson (1994). If the ratio is greater than 1.0 which denotes a positive skewness which implied the distribution with more proceeds above the median return. In contrast, the ratio

which is less than 1.0 denotes a negative skewness. From table 3, it shows that skewness ratio was different from 1.0 over the time periods.

Skewness equals (High 10t Percentile Return – Median Return)/ (Median Return – Low 10th Post-Modern Portfolio Theory formulation reduced this puzzle and also utilized a broader class of asymmetrical distribution. Lognormal distribution permitted the positive as well as negative skewness. It accommodated all asset classes which comprised options, derivatives and hedge funds. This could be concluded that lognormal distribution had better representation of the shape of investment returns as indicated by Brian M. Rom, (1994).

Basic Mathematical Formulas for the three Parameter Lognormal as mentioned by Hal Forsey, (2006). Sample mean, sample standard deviation and extreme value were the three basic parameters to estimate.

There are several auxiliary parameters: $\text{Dif} = \lvert \text{Mean} - \tau \rvert$ $\sigma = \ln\left(\left(\frac{SD}{\text{Dif}}\right)^2 + 1\right)$ $\mu = \ln(\text{Dif}) - \sigma^2$	$\alpha = \frac{1}{\sqrt{2\pi} \cdot \sigma}$ $\beta = -\frac{1}{2\sigma^2}$

Source: Hal Forsey, 2006

- Formula for the *lognormal curve* $f(x)$:

If the extreme value is a minimum and *x* is greater than the extreme value :

$$f(x) = \frac{\alpha}{x - \tau} \exp(\beta \cdot (\ln(x - \tau) - \mu))$$

If the extreme value is a maximum and *x* is less than the extreme value then

$$f(x) = \frac{\alpha}{\tau - x} \exp(\beta \cdot (\ln(\tau - x) - \mu))$$

- Formula for the *lognormal cumulative distribution function* $F(x)$*:*

$$f(x) = 1 - \frac{erf_c(\ln(x-\tau)-\mu)}{2\sqrt{2}\cdot\sigma}$$

$$f(x) = 1 - \frac{erf_c(\ln(\tau-x)-\mu)}{2\sqrt{2}\cdot\sigma}$$

3.1.3 Sortino Ratio

Sortino Ratio was introduced by Sortino and Price (1994), and it is used to measure risk adjusted returns for the target and downside risk. It is a modified version of Sharpe ratio. It assists investment manager or investor to estimate portfolio risk. Sharpe ratio was developed by Nobel Laureate economist William Sharpe, this ratio measures risk adjusted performance. Richard Loth, (2010) indicated that the theory measured the excess return or called Risk Premium per unit for an investment stock pr strategy. It quantifies the return (alpha) over the volatility (beta) that assumed in the portfolio.

Sortino Ratio	Sharpe ratio
S = $\frac{R-T}{DR}$ R = annual rate of return for the investment T = required rate of return DR = downside risk, square roof of the target semi-variance.	S = $\frac{E(Rp)-E(Rp)}{std.dev.[E(Rp)-E(Rp)]}$ R = asset return Rf = return on a benchmark asset, such as risk free rate σ = Standard deviation of the asset.

Source: Brian M. Rom & Kathleen W. Ferguson, (1994)

The Sharpe ratio was interpreted as the risk premium per unit of total risk. Because it can be computed and interpreted easily, so the Sharpe ratio is often employed in practice as well as in theoretical research by Modigliani and Modigliani (1997).

However, the modified version- Sortino ratio only comprised of downside risk as a deviation from the norm of minimum acceptable return. Compared to Sharpe ratio which penalized both upside and downside volatility equally, Sortino ratio penalized only those returns falling below a user-specified target. Thus, measured risk adjusted return had treated risk more realistic than the Sharpe ratio.

4 Conclusion

According to Nolan Bean (2009), he indicated that in real confidence in a portfolio's diversification relied on those investors had to understand the primary market risk factor of each asset in their portfolio and diversify those risks. Institutional investors need to find for themselves an asset allocation policy that contains some of the categories, such as global equity, global fixed income, real assets and diversifying strategies. This would help them to better capture risk and had a more intuitive way to construct a portfolio. Researchers such as Cynthia Harrington (2002) indicated that many advisors used Post-Modern Portfolio Theory to some extent recently. It was well known that investors were emotional and weighed the risk and returns of reaching specific goals. However, fewer advisors used some of the post-modern tools like Sortino ratios and downside risk measures.

As mentioned above by Vern Sumnicht (2008) it was important to reconsider the founding framework of Modern Portfolio Theory. For example, now that we understand that the equating risk implied that the investors were indifferent to an investment's upside volatility or downside volatility. Certain asset classes had showed increased signs of correlation convergence. Investors could not reduce their risk through diversification without investing in asset classes with had low correlation. Using the post-modern portfolio theory concepts can actually guide investors through complex financial training to their advantage.

It may be dangerous to our investors' financial health to subjectively make adjustments to the asset allocation software. Equating risk with standard deviation implies that investors are indifferent to an investment's upside volatility or downside volatility. This violates logic, when we know investors are much more concerned with unexpected losses. Certain asset classes are showing signs of increasing correlation convergence. Our investors can't reduce their risk through diversification without investing in asset classes with low correlation.

In the economy, investment markets, and investor utility are all affected by more than just risk, return and correlation. Therefore, asset allocation models need to be robust enough to consider additional capital and economic factors and to apply them to asset allocation and re-balancing decisions.

Post-Modern Portfolio Theory and research in behavioural Finance shows how to apply the theory to increase investment output and to improve the MPT principles to a different level of functionality. These enhancements are used by investment consultants to improve the decision making of those who rely on them to attain their financial objectives. The use of optimization algorithm can be applied objectively with limited subjective involvement. This application carries a measure of risk with a possibility of loss. Better results can be acquired by using a robust model for determining and re-balancing a portfolio's optimal asset allocation as capital market and economic factors change. It would also be beneficial to allocate portfolios among low correlated assets to better reduce risk through diversification. Vern Sumnicht (2008) indicated that Post-Modern Portfolio Theory and research in Behavioral Finance had pointed the way showing how to apply the Post modern Portfolio Theory to improve investment results and to upgrade the MPT principles to a new level of usefulness. These improvements are used by consultants to improve the lives of those who rely on them to reach their financial objectives.

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