Modern Portfolio Theory: Expectation vs. Reality
A White Paper by Manning & Napier
MPT Background

Academic studies have shown that the asset allocation decision accounts for a meaningful portion of long-term portfolio returns\(^1\). As such, the asset allocation decision remains the central element of portfolio construction in the investment industry today. While there are numerous methods and theories designed to aid with the asset allocation decision, Modern Portfolio Theory (MPT) remains one of the most popular. Invented by Harry Markowitz in the 1950s, MPT is based on several key principles:

- Portfolios are described by various levels of expected risk and return
- Expected risk is defined as volatility of expected returns (i.e., standard deviation)
- “Optimal” portfolios can be constructed by either minimizing expected risk for a given level of expected return or maximizing return for a given level of risk.

The attractiveness and longevity of MPT likely, in part, rests on its simplicity. The theory condenses the often complex realm of investor goals and objectives into quantitative expected risk and return statistics. With these volatility and return inputs along with correlations (a measure of how two asset classes/securities move in relation to each other) between various asset classes, MPT states that investors can construct portfolios that are designed to meet their goals and objectives.

Within the scope of MPT, one portfolio is considered superior to another if it either achieves a greater level of expected return for a given level of expected standard deviation or a lower level of standard deviation for a given return. All portfolios that maximize expected return at various volatility levels or minimize expected volatility and various return levels are considered “optimal” and lie on the “efficient frontier” (illustrated on the right). For example, portfolio 3 would not be considered optimal as portfolio 1 is expected to achieve a higher return at the same standard deviation. Likewise, the chart illustrates that MPT assumes that investors will demand a higher level of expected return as a portfolio’s expected volatility increases (i.e., investors require compensation for taking on additional “risk”). Hence, MPT implies a positive relationship between expected returns and expected volatility.

Efficient Frontier

While the following analysis focuses primarily on the quantitative aspects of MPT (e.g., return and volatility inputs), the theory relies on several more theoretical assumptions which have also been debated since its introduction. Several of these assumptions are listed below.

- The financial markets are efficient (i.e., a security’s market price accurately reflects its value and all the available information about the security). While rather elegant in theory, the concept of market efficiency has been repeatedly contested in the industry leading to several varieties of the “efficient market hypothesis.”
- Investors are rational and are able to accurately evaluate the value of various securities in the context of their own risk tolerance and market/economic fundamentals. Observations of actual investor behavior have led many to question the assumption of investor rationality. In fact, the field of behavioral finance has formalized several specific examples of irrational investor behavior including “herding” and “anchoring bias.”
- Financial transactions including investing, lending, and borrowing can be executed without costs. In reality, any participant in the financial markets likely knows from experience that transaction costs not only exist but can meaningfully affect investment returns.
MPT Application

While some investors may consider MPT an intuitive method for constructing portfolios, the actual applications of MPT generally differ from that of the theory along several notable dimensions.

- While MPT is designed to utilize expected return and volatility assumptions, historical data is most often utilized in practice due to the potential difficulty of making precise, forward looking return and standard deviation estimates.
- The number of asset classes included in portfolio construction may have meaningful effects on the composition of the optimal portfolio.
- Because optimal portfolios based on MPT, at times, can be relatively undiversified (i.e., concentrated in certain asset classes), portfolios are constructed with asset class constraints (e.g., no more than 20% in small cap stocks).

In general, both the use of historical data and asset class constraints are understandable from a practical standpoint. However, their widespread use when constructing MPT-based portfolios may lead to actual portfolio returns and volatility over a given time period that differ meaningfully from those expected for optimal portfolios. Additionally, these optimal portfolios may adjust their asset class exposure somewhat slowly over time even as market conditions change meaningfully. Likewise, the specific asset classes included in the optimization process are likely to have a significant impact on the final composition of the optimal portfolio.

Using Historical Returns

According to MPT, the first step in determining an optimal asset allocation is generating the required return and risk inputs. These inputs should theoretically represent forward looking return and volatility expectations for various asset classes. However, most investors recognize that accurately predicting future returns and volatility statistics across asset classes is extremely challenging. In general, while it may be possible to position a portfolio to take advantage of certain short-term market return drivers or potentially benefit from broad based long-term themes, very few investors would likely express a great degree of confidence if asked to predict equity returns for the next 10 to 20 years to the nearest percent. Thus, in lieu of making forward looking return predictions most investors utilize historical return and volatility data as inputs into their MPT models.

Of course history isn’t static, and if a person looks back at the fifty years from 1930 to 1980 compared to the following twenty years (i.e., 1980 to 2000) they would probably agree that the two periods have many notable differences. For instance, one can point to differences in technology, the labor markets, and the state of global trade. However, when investors use historical data to construct optimal portfolios, they are implicitly making the assumption that the future will be like the present, when this has obviously not been the case.

To illustrate this point, the charts below and on the following page show the efficient frontiers and optimal portfolios for the three 20 year periods from 10/1954 to 9/2014. The charts map how the efficient frontier evolved over time and clearly show that portfolios considered optimal during one 20 year period were meaningfully different from the optimal portfolio in the subsequent 20 year period.

Assumptions for the scenario are as follows:

- Portfolios include 4 asset classes: Cash\(^2\), U.S. Intermediate-Term Govt. bonds\(^3\), U.S. large cap stocks\(^4\), U.S. small cap stocks\(^5\).
- Expected returns and volatility based on historical asset class data from 10/1954 to 9/2014.
- Optimal portfolios designed to minimize standard deviation at a target annualized return of 8% (i.e., the approximate long-term return of a portfolio consisting of 50% U.S. large caps stocks / 50% U.S. Intermediate-Term Govt. bonds).
- Charts illustrate the efficient frontier and optimal portfolio for the three non-overlapping 20 year periods from 10/1954 to 9/2014.

Efficient Frontiers (Mean Variance Optimization)
As the illustrations show, when utilizing the parameters and assumptions presented in the above scenario, the optimal portfolio for achieving the 8% return target from 10/1954 to 9/1974 would have been fairly diversified across asset classes. This hypothetical optimal portfolio based on MPT would have provided meaningful exposure to U.S. large and small cap stocks, as well as to cash and intermediate-term government bonds. However, in the subsequent 20 year period, an optimal portfolio would have substantially reduced exposure to U.S. small cap stocks (transitioning from an allocation of 47% to 5%), almost eliminated U.S. large cap stock exposure, and been invested primarily in cash.

These meaningful changes in portfolio composition are understandable as cash provided an especially attractive tradeoff for reaching an 8% target return during the second 20 year time period. While over the two 20 year time periods the volatility of cash returns remained virtually unchanged from one period to the next, absolute returns increased from approximately 4% annualized to more than 7% over the next 20 years. As such, even though U.S. small cap stocks generated approximately 20% returns between 10/1974 and 9/1994, allocating the majority of the portfolio’s assets to cash would have sufficed to come close to the required 8% return target. Thus, a much smaller allocation to small cap stocks was optimal given their significantly higher volatility (i.e., a standard deviation of approximately 21% versus 1% for cash).

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Substantial variation between the allocations of the optimal portfolios for the 10/1974 to 9/1994 and 10/1994 to 9/2014 20 year periods is also evident. While cash returns from 10/1974 to 9/1994 were sufficient to warrant an approximate 87% allocation in the optimal portfolio, the optimal cash allocation decreased to 0% in the following 20 year period. Cash was largely replaced by intermediate-term government bonds in the optimal portfolio as the Federal Funds Rate declined from approximately 15% at the beginning of 1982 to between 0-0.25% as of 9/30/2014.

Determining the Number of Asset Classes

Since MPT-based optimal portfolios can, at times, have concentrations in a given asset class, constraints are often imposed to construct what investors consider to be more diversified portfolios. However, even before constraints are placed on certain asset class allocations, an investor must determine which asset classes will be utilized to construct the optimal portfolio. As the table below illustrates, the addition of even a single asset class can meaningfully change the asset allocation of the optimal portfolio.

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<thead>
<tr>
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<tbody>
<tr>
<td>U.S. Large Cap Stocks</td>
<td>22%</td>
<td>1%</td>
<td>16%</td>
</tr>
<tr>
<td>U.S. Small Cap Stocks</td>
<td>47%</td>
<td>5%</td>
<td>21%</td>
</tr>
<tr>
<td>Intermediate Govt Bonds</td>
<td>10%</td>
<td>7%</td>
<td>63%</td>
</tr>
<tr>
<td>Cash</td>
<td>21%</td>
<td>87%</td>
<td>0%</td>
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### Asset Allocation of Optimal Portfolio

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Without Long Govt Bonds</th>
<th>With Long Govt Bonds</th>
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<tbody>
<tr>
<td>U.S. Large Cap Stocks</td>
<td>16%</td>
<td>11%</td>
</tr>
<tr>
<td>U.S. Small Cap Stocks</td>
<td>21%</td>
<td>14%</td>
</tr>
<tr>
<td>Intermediate Govt Bonds</td>
<td>63%</td>
<td>45%</td>
</tr>
<tr>
<td>Cash</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Long Govt Bonds</td>
<td>0%</td>
<td>30%</td>
</tr>
</tbody>
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Correlations among various asset classes can play a large role in determining the asset allocation of the “optimal” portfolio. However, just as return and volatility characteristics have varied over time, asset class correlations can also differ across market environments. For example, from 10/1974 to 9/1994 the correlation between U.S. large cap stocks and intermediate-term government bonds was 0.28. That correlation decreased to -0.20 during the next 20 years. These swings in correlation are likely to have notable effects on portfolio construction within an MPT framework since the return and volatility profile of various asset class combinations can vary as their correlations change. Overall, this analysis illustrates that asset class returns, volatility, and correlations have varied widely even over longer-term time periods which makes forecasting these statistics based on historical data a challenging exercise.
Specifically, the scenario on the previous page analyzes the impact of adding long-term government bonds to the asset class mix utilized in the prior scenario for the period of 10/1994 to 9/2014 (i.e., the last 20 years). It is evident that the addition of long-term government bonds meaningfully changes the composition of the optimal portfolio. For example, assuming the 8% return target utilized throughout this analysis, an optimal portfolio which does not include long-term government bonds would allocate approximately 21% and 63% to U.S. small cap stocks and intermediate-term government bonds, respectively. However, when long-term government bonds are included, the optimal portfolio assigns a 30% allocation to the asset class and the optimal U.S. small cap and intermediate-term government bond allocations decline to 14% and 45%, respectively. Thus, the number of asset classes utilized to construct the optimal portfolio may have a meaningful impact on its ultimate composition. In turn, having a clear understanding of why certain asset classes are included in the optimization process is an important factor in analyzing the results of MPT-based portfolio optimization.

**Imposing Asset Class Constraints**

To illustrate the effects that constraints can have on the composition of the optimal portfolio, the chart below compares constrained versus unconstrained optimal portfolios during the 20 year periods from 10/1974 to 9/1994 and 10/1994 to 9/2014. The unconstrained portfolio during each 20 year period utilizes the same asset classes outlined on page 3, while the constrained portfolio imposes the following asset class constraints.

- Maximum 10% cash
- Maximum 20% U.S. small cap stocks
- Minimum 30% U.S. large cap stocks.

When compared to the optimal unconstrained portfolio, it is evident that the optimal constrained portfolio has generally remained more static over time. For example, without imposing constraints, the optimal allocation to intermediate-term government bonds during the period of 10/1974 to 9/1994 would have been only approximately 7%. That allocation would have increased significantly to approximately 63% during the next 20 years. In contrast, the allocation to intermediate-term government bonds would have remained relatively static at between 55% and 60% during each 20 year period when constraints were added.

Looking at the actual returns and volatility characteristics of the constrained versus unconstrained portfolios, the effects of constraints resulted in portfolios that would have been considered “sub-optimal” based on MPT during both 20 year periods. For example, from 10/1974 to 9/1994, the relatively static 30% U.S. large cap stock allocation imposed by the constraints would have resulted in a portfolio with a higher than desired return and volatility profile. Specifically, the “optimal” asset mix in the constrained portfolio had a minimum return of approximately 11% (versus the desired 8% target), along with a standard deviation of 8% versus only 2% for the unconstrained portfolio which held mostly cash. Despite exceeding the target return, the constrained portfolio would still be considered “sub-optimal” according to MPT as investors could have achieved an 11% return target over the period with a standard deviation of only approximately 7%.
Conclusion

Overall, while Modern Portfolio Theory enjoys widespread use in the investment industry, investors should keep in mind several potential issues that may arise with the theory’s actual application. First, the use of historical data to generate inputs implies that future asset class returns and volatility will reflect those of the past when, in fact, return and volatility statistics within a given asset class can vary greatly even over longer-term time periods. Second, the asset classes utilized in the optimization process can have a meaningful impact on the composition of the optimal portfolio. As such, it is important to understand why certain asset classes are included or excluded in the modeling process. Lastly, imposing asset class constraints could result in portfolios which may not truly be optimal as defined by MPT and potentially lead to muted portfolio adjustments in response to changing market conditions. Ultimately, the successful application of MPT will depend on an investor’s ability to accurately forecast future returns and volatility statistics, utilize the “correct” mix of asset classes, and effectively impose constraints without resulting in portfolios considered “sub-optimal.”

When deciding the merits of MPT, investors should also evaluate its more theoretical assumptions including the concepts of market efficiency and investor rationality. Numerous market bubbles and crashes over the past century have led many investors to question the concept of market efficiency as certain market segments at times reached valuations which, in retrospect, were not entirely consistent with their underlying fundamentals. Additionally, differences between the long-term performance of various investment products versus the actual performance of individual investors who held those products, accounting for their buy and sell decisions, appear somewhat contrary to the assumption of investor rationality.

Thus, while Modern Portfolio Theory may provide investors with information that may be useful in a specific context, an appropriate asset allocation for a portfolio should depend on the current market environment, as well as an investor’s long-term goals and objectives, including their time horizon, spending needs and specific circumstances. Moreover, while making precise forward looking asset class return predictions has proved challenging for most investors, we believe that an active, disciplined investment process that takes into account current market conditions has the potential to identify attractive securities and market segments across a variety of market environments.