Can You Afford to Underestimate Risk By 50%?

Geoff Considine, Ph.D.

More and more people are responsible for their own portfolio planning, but most investors do not have sufficient information about the aggregate risk and return characteristics of their portfolios---or how to improve them. It seems that everyone agrees that there is a pressing need for investors to have better tools and information, but there is no consensus as to the solution. The Pension Protection Act 2006 has endorsed the use of computer models to help in providing objective advice on investment allocation, which should help the situation, but very few people—including professional advisors and planners—understand enough about these models to be confident in selecting and using these tools effectively. There is no question that good computer models can and should be used to help investors in making better planning and allocation decisions. That said, using a model without a firm grasp of how it works (and whether it can handle your portfolio) can lead to bad decisions.

A portfolio planning tool must be probabilistic—which is to say that it must account for uncertainty in the future performance of the assets in your portfolio. The most common class of probabilistic tools for portfolio management is Monte Carlo models. If you are unfamiliar with the basic principles of Monte Carlo analysis, we provide an overview at http://www.quantext.com/MCFaq.html. In professional portfolio and risk management applications, Monte Carlo methods are firmly established as the standard of practice. There are many different ways to simulate a portfolio using Monte Carlo, but the major classes of simulation for portfolio management can be described in two broad classes:

1. Index Mapping
2. Modeling Individual Assets

In Index Mapping, each component of a portfolio is mapped to one or more indices. This is the standard of practice in financial planning models and can be fairly sophisticated or very simple. The basic idea in the standard applications is that you must 'map' each investment in your portfolio to track an index or perhaps a combination of indices. A standard approach is to assume that U.S. equities in a portfolio will track the S&P500, for example, and that foreign equities track the EAFE index. Once you have assigned each

investment to a market index, you then simulate the each index, accounting for the correlation between them. Once you have simulated the indices, you calculate the total risk and return for your portfolio by the relative allocation into each index.

A more complex form of Index Mapping, in which you map a stock or fund to a series of indices by assigning fractional weights to each index, is called ***Style Analysis***. Style Analysis was pioneered by Bill Sharpe and can be succinctly described:

"…determining a fund's exposures to changes in the returns of major asset classes is termed *style analysis*. The goal is to find the "best" set of asset class exposures that totals to 100% and conforms with rudimentary information concerning the fund's policies"

Bill Sharpe, Asset Allocation: Management Style and Performance Measurement (1992)

Once you have 'mapped' the returns on a fund to a series of indices, you can use Monte Carlo to simulate these indices. The portfolio is then represented by proportional allocations into each index, representing cumulative weights from all funds in the portfolio.

Because Style Analysis represents any asset in terms of one or more indices, ***these models assume that the correlations between any assets can be fully captured by their correlations to the indices.*** This is a strong assumption—and one that may not provide a good description of the relationships between investments, depending on the portfolio.

Style Analysis uses an automated algorithm for mapping a fund to a series of asset classes. In Sharpe's paper (cited above), he finds that only 40% of the returns from the average growth equity fund is actually mapped to a growth index using Style Analysis. This might mean that these funds do not follow a 'pure style' as Sharpe suggests, but it may also mean that the automated algorithm simply has fairly limited skill in correctly identifying the fund style. From a practical standpoint, there is no concrete way to determine which factor is dominant. An article in the ***Journal of Financial Planning*** in

2000 explored this issue in detail (link at end of this article). The authors tested a ***Style Analysis*** model to see whether it correctly assigned a series of very narrowly-focused mutual funds to the indices for these styles. They wanted to see, for example, whether ***Style Analysis*** would correctly identify that a small-cap fund should be assigned to follow a small-cap index. They compared the Style Analysis classification to standard classification of a fund by analysts—of the sort provided by Morningstar, for example. The results from the ***Journal of Financial Planning*** article suggested that Style Analysis might correctly figure out the proper asset class for as few as 40% of small cap funds. The same level of classification accuracy was found for growth funds. These results are consistent with Sharpe's earlier analysis.

The second option for modeling (the first being Index mapping into a single index or Style Analysis) is to simulate each asset in the portfolio, whether it is an individual stock or fund. This type of model is the most accurate, but also requires more complex analytics. In this approach you must calculate the volatility and expected future return for each portfolio component, as well as accounting for the effects of correlation between all portfolio components on total portfolio risk. Quantext Portfolio Planner models individual holdings in this way and is not limited by 'mapping' limitations imposed by Style Analysis. For a comparison, see:

http://www.quantext.com/TrueDiversification.pdf

Risk Management: A Practical Guide (by the RiskMetrics Group) provides some guidelines for when Index Mapping will work for modeling a portfolio and when it is necessary to model individual equities or funds (see Section 9.5):

http://www.riskmetrics.com/pdf/RMGuide.pdf

The guide suggests modeling individual equities if a portfolio (1) has more than 5% in a single stock or (2) has a concentration in a specific industry. Only a model that analyzes the risk characteristics of individual stocks and/or specific industries can capture the unique portfolio impacts of a concentrated holding. The problem for Monte Carlo tools that use a form of Index Mapping is that they will be most appropriate when the user is

already reasonably well diversified. Many investors are not well diversified, and this is precisely why they need help:

"Many plan participants appear to be engaged in questionable investment behavior in their DC [defined contribution] plans [i.e. such as 401(k) plans]. This ranges from the failure to rebalance funds periodically, to fund selections that fail to diversify retirement assets in general and over investment in employer stock in particular. Fidelity Investments (2003) found in one survey that a quarter of DC plan participants held only a single investment asset in their 401(k) plans; and Hewitt Associates (2002) notes that 41 percent of plan participants held only one or two funds in 2002….Other data show that more than 8 million 401(k) participants held more than 20 percent of their plan assets in company stock (VanDerhei, 2002). Overall, company stock still dominates many pension plan accounts, averaging 42 percent of balances among participants holding *any* company stock. (Hewitt Associates, 2002)."

Arnone, Educating Pension Plan Participants (2004)

Investors need tools to help them get more diversified, or understand and manage the risk that their portfolio concentrations create, but the standard tools are only appropriate when you already have a diversified portfolio. For example, the paragraph above suggests that eight million investors have more than 20% of their holdings in company stock---but the models most often used in financial planning will not be able to quantify the risk of these concentrated positions or provide guidance on how to improve the asset allocations.

Risk Management: A Practical Guide notes that the fundamental limitation with all forms of Index Mapping models is that they cannot capture firm-specific risks. By extension, they also will not be able to account for the impact of firm-specific correlations. Firm-specific risk is the risk in an investment that is not due to the movement of the broader markets. This is not a trivial issue. Any sort of concentration in specific stocks or even in a specific industry (at a level of concentration greater than the index set that you map to) exposes your portfolio to risks that are ignored by standard retirement models. Further, these risks are becoming more and more significant in time:

"a [2001] study by Campbell, Lettau, Malkiel and Xu has shown that, while overall volatility of markets and stocks have been stable over the last thirty years, there has been a noticeable *increase in the firm-specific risk* component of individual stock returns. In fact, they show that this component has more than doubled in importance between 1962 and 1997 for most individual stocks in U.S. markets."

Many investors have concentrated portfolios and the specific risks associated with these concentrated holdings will not be well modeled by Index Mapping. Further, there are often good reasons why an investor will want to have holdings that are fairly concentrated. Employees may quite rationally wish to have concentrated holdings in their employer's stock. The value of a model is in helping users to manage around these holdings with their other investments. Further, the correlation impacts associated with fairly concentrated asset holdings – often too narrow to be captured by standard Index Mapping models – can be substantial.

A fund may be mapped to an index that is not a good representation of that fund's risk and return for either of two reasons:

(1) Limited indices in the set of choices
(2) Misclassification in the process of assigning a fund to one or more indices

So what difference does it make if you don't get your investments into indices that are a good match to the properties of the investments? This depends on the specific implementation, but simple examples can illustrate how substantial the issue can be.

Fund Name	Percentage of Funds
SPY	20.0%
QQQQ	20.0%
EFA	0.0%
EEM	20.0%
AGG	40.0%

Table 1: Sample portfolio

Consider the portfolio above—with four fairly diverse index fund investments. The portfolio has 20% in the S&P500 (SPY), 20% in the NASDAQ100 (QQQQ), 20% in emerging markets (EEM), and 40% bonds (AGG). A standard Index Mapping for retirement planning assigns all U.S. equity holdings to the S&P500 and all foreign equity holdings to the EAFE index. If you were to analyze the portfolio above using this approach, the QQQQ holdings would be assigned to the S&P500 and the EEM holdings would be assigned to track EAFE. The portfolio above would be treated as though it were the identical to this one (EFA tracks the EAFE index):

Fund Name	Percentage of Funds
SPY	40.0%
QQQQ	0.0%
EFA	20.0%
EEM	0.0%
AGG	40.0%

Table 2: How standard model would see Sample Portfolio

The total risk (i.e. volatility) for the actual portfolio is 47% greater than the Index Mapping model would suggest because the model takes the portfolio in Table 1 and treats it as though it is actually the portfolio in Table 2. The portfolio in Table 1 has almost 50% more risk than the Index Mapping model would calculate—simply due to the limitations in assigning asset classes. This is not an especially extreme example—this portfolio still has 40% in bonds, which tempers the results. It is important to understand that asset allocation (and resulting portfolio risk and return) is a major determinant in how much you will be able to reliably draw in income from your portfolio during retirement. The classification biases shown here, and subsequent skewed analysis of portfolio risk and return properties, can equate to ten years or more of retirement income.

Let's recap this discussion. Surveys show that there are a lot of people with portfolios that are not well diversified. Investors often hold substantial positions in their employer's stock or simply hold one or two funds. The most commonly used computer-based retirement planning models (i.e. Index Mapping) are the right choice for portfolios with

diversified holdings. These models tend not to be able to properly characterize a portfolio with substantial firm-specific or industry-specific risk, and there are indications that firm-specific risk is increasing in importance (as opposed to market risk) in individual stocks. Finally, due to incorrect classification of investments, the risks in the portfolio as a whole may be substantially misstated even for portfolios with minimal firm specific risk (as in the example above).

An investor seeking to harness the growth in emerging markets needs a model that can differentiate between the portfolio characteristics of an emerging markets fund (such as EEM) and a developed-market index fund (such as EFA). The Index Mapping models commonly available to individual investors do not accomplish this. An employee with holdings in his employer's stock needs to understand the risk / return characteristics of that stock and how to manage this exposure in conjunction with his/her other holdings---but conventional Index Mapping models cannot properly account for firm-specific risk. An employee whose employer has a high-Beta tech stock, for example, will often derive substantial value from diversifying with a utilities index fund such as IDU (because IDU has only 8% correlation to the NASDAQ 100), but Index Mapping models frequently fail to identify such opportunities.

The alternative is to use a model that models individual stocks and funds. This is what Quantext Portfolio Planner (QPP) does. The primary disadvantage of this approach is that it is data intensive, but with computer power available on every desk (or lap), this is not a significant problem. A QPP run takes 1-2 minutes on my laptop (at the longest). QPP has been extensively tested for its ability to deal with individual stocks and the kinds of concentrated funds that Index Mapping models cannot capture. QPP was, in fact, developed to address these problems.

The title of this article is deliberately provocative. An investor really can end up with a highly flawed estimate of total portfolio risk and return characteristics using standard Index Mapping tools. Based on a range of tests and a review of the literature, I feel that errors on the order of 50% in risk estimation using standard tools could be quite common.

This is not due to errors in the tools—but rather because investors may be using tools that are not appropriate for their portfolios. Many investors will, quite rationally, choose portfolios that are not mirror images of the indices---and it makes sense to look for a tool that can manage a wide range of portfolio choices. Further, part of the value in using Monte Carlo planning tools is to be able to see the incremental portfolio impact of adding or changing the allocation to a specific fund or stock--- but many standard tools cannot accomplish this task accurately. When investors or their advisors are looking at models for portfolio management and planning, it is crucial to understand the limitations of a modeling framework and to make sure that your tools are appropriate to the problem that you wish to solve.

Links:

Arnone paper
http://rider.wharton.upenn.edu/~prc/PRC/WP/WP2004-7.pdf

Sharpe paper on style analysis
http://www.stanford.edu/~wfsharpe/art/sa/sa.htm

Karolyi paper
http://www.cob.ohio-state.edu/fin/faculty/karolyi/papers/WhyVolatilityMatters.PDF

Journal of Financial Planning paper on tests of style analysis

https://www.fpanet.org/journal/articles/2000_Issues/jfp0800-art13.cfm

Quantext Portfolio Planner *is a Monte Carlo portfolio management tool. Extensive case studies, as well as access to a free extended trial, are available at*

http://www.quantext.com/gpage3.html