Risk

WE CAN'T BUILD an optimal portfolio just by looking at projected returns; we also have to consider risk. The optimal portfolio is not the one with the highest expected return, but the one with the highest expected return for a given level of risk, or the one with the lowest expected risk for a given level of return.

Risk, however, is not an easy subject. Its meaning is imprecise; unlike return, which has one unambiguous measure, risk has several measures. Risk can be measured by variability or volatility. It can be measured by the probability of experiencing extreme outcomes. It can be measured by the probability of loss or the probability of a large or catastrophic loss. And it can also be measured by new factors devised by researchers in other disciplines and recently applied to the study of capital markets (see the accompanying box).

Wise investors must know when market conditions have diverged from the average or are likely to do so.

For now, we will follow the convention of modern portfolio theory and assume that risk is best captured by the variability of returns – which, in turn, implies certain likelihoods of extreme outcomes and loss. As noted in the accompanying box, however, our understanding of risk in capital markets is evolving and new measures are being employed. We will come back to the subject of the meaning and measurement of risk again and again in future issues.

To build the optimal portfolio, then, we need a measure of the expected variability of the portfolio in addition to its expected return. To quantify the expected variability of a portfolio, two sets of statistics are needed. First, we need a quantitative estimate of the risk or variability of each asset class. How much riskier will stocks be compared to bonds? How will the risk of international stocks compare to domestic stocks, or the risk of real estate compare to bonds, for example? Second, we need an idea of the extent to which returns among asset classes will be linked or correlated. Asset categories whose returns are highly correlated provide little diversification benefit, whereas an asset category whose return is not highly correlated with others offers the potential benefit of reducing total portfolio risk even if it is a high-risk investment on a stand-alone basis.

We use historical information - to the extent it is available - as the starting point for our future risk and correlation projections. We measure risk by the variability of returns and use the statistical measure of standard deviation as the risk measure. Assets with highly variable returns have high standard deviations and are more likely, all other things being the same, to generate losses. Conversely, assets with low standard deviations are less likely to produce losses.

Risk measures are not fixed parameters, however. They vary over time as market behavior changes and the volatility of markets change. (In technical terms, we would say that capital market returns are heteroskedastic: their variability is not constant). We would be naïve to use historical standard deviations as proxies for future risk without making some judgments about the likelihood that future market conditions will result in asset returns being as variable as they have been in the past. Although one of the guiding principles for investors should be a belief in the reversion to the mean – namely, a belief that measures that diverge from historical averages are likely to trend back to the average over time – we also believe that wise investors must know when market conditions have diverged from the average or are likely to do so.

EXPECTED RISK BY ASSET CATEGORY

	Asset Category	Expected Risk (Standard Deviation)
1	U.S. large-cap equities	20%
2	U.S. small-cap equities	28%
3	UK equities	24%
4	Euro area equities	27%
5	Japan equities	32%
6	Emerging-market equities	34%
7	Venture capital	36%
8	Real estate	17%
9	U.S. government bonds (long-term)	10%
10	U.S. government bonds (intermediate-term)	6%
11	U.S. inflation-protected bonds	6%
12	U.S. corporate bonds	9%
13	High-yield securities	12%
14	Mortgage-backed Securities	5%
15	Foreign investment-grade bonds	13%
16	Emerging-market sovereign debt	20%

Figure R.1: Expected Risk by Asset Category
Source: *Asset Allocation Advisor*

Figure R.1 shows the expected risk as measured by the projected standard deviation for each of the asset categories under consideration in our portfolio allocation. With one notable exception, the projected standard deviations are approximately equal to the historical standard deviations of annual total returns (in U.S. dollars) over the longest time period possible with reliable measures. The one exception is for U.S. small capitalization equities. The projected risk for this class is based on a 70-year rather than an 80-year history, which excludes the years before passage of the Securities Act of 1933 and the Securities Exchange Act of 1934. The passage of these acts appears to have reduced the information risk associated with investing in small stocks much more significantly than for large stocks.

Figure R.2 shows our asset categories ranked by expected risk from the highest to the lowest risk. As one might expect, equity categories have the highest expected risk, with U.S. large-cap equities being the least risky of all equity categories. Real estate, with an expected 17% standard deviation, ranks below all equity categories and above most fixed income categories. Fixed-income asset categories have the lowest expected risk, with foreign bonds projected as riskier than domestic bonds. Somewhat surprisingly, U.S. corporate bonds rank just below U.S. long-term government bonds in expected risk, consistent with relative risk measures for the past ten, twenty, forty, sixty, and eighty years.

ASSET CATEGORY RANKED BY EXPECTED RISK

Risk Ranking	Asset Category	Expected Risk (Standard Deviation)
1	Venture capital	36%
2	Emerging-market equities	34%
3	Japan equities	32%
4	U.S. small-cap equities	28%
5	Euro area equities	27%
6	UK equities	24%
7-t	U.S. large-cap equities	20%
7-t	Emerging-market sovereign debt	20%
9	Real estate	17%
10	Foreign investment grade bonds	13%
11	High-yield bonds	12%
12	U.S. government bonds (long-term)	10%
13	U.S. corporate bonds	9%
14-t	U.S. government bonds (intermediate-term)	6%
14-t	U.S. inflation-protected bonds	6%
16	Mortgage-backed bonds	5%

Figure R.2: Asset Category Ranked by Expected Risk
Source: *Asset Allocation Advisor*

Standard deviation is the classic risk measure used in Markowitz's mean variance portfolio optimization, the focus of this issue of the Asset Allocation Advisor *(see the last article on the Art and Science of Asset Allocation). Some comment is warranted on the use of this statistic as a risk measure. First, it should be noted that the appropriate indicator is not precisely the standard deviation but the standard deviation relative to the average return. If we can expect an average return of 30% from an asset class, a 25% standard deviation for returns on the class makes the category less risky than one with a 10% expected return and a 15% standard deviation. Unfortunately, such animals don't exist, and we find that higher returns invariably come with higher variability – proof once again that there is no such thing as a free lunch!*

Second, a considerable body of research done in recent years suggests that capital market returns are not normally distributed (in other words, they do not follow the normal bell curve) and that they are not serially independent (in other words, returns show evidence of long memory and are influenced by historical conditions). At the same time, research has shown that capital market returns show patterns best described by the fractal geometry that has been developed to describe and analyze turbulent or chaotic natural systems (more on this in the last section).

We can draw several conclusions from this research. First, we will underestimate the probability of large gains or losses occurring if we assume returns are normally distributed. We have to know more about projected returns than just their standard deviation to understand the possibility of extreme results (a subject we will take up in future issues). Second, fractal analysis of capital market returns produces descriptive measures such as the Hurst factor and the fractal dimension that can enhance our understanding and measurement of risk. They are not, however, as easily measured or widely understood as the standard statistical measures, nor is there a standard theory of how such risk measures balance out in a portfolio of several asset classes. Third, since returns are not normally distributed and are not serially independent, the optimal conditions for Markowitz mean-variance optimization are not attained. Unfortunately, to date, no more generalized system has been developed to expand mean-variance optimization from what now appears to be the special case of normally distributed returns.

Portfolio theory and optimization is a developing science, as is the science of risk measurement. These are exciting times. One of the primary purposes of this publication is to keep fiduciaries and managers up to date on developments in the science of portfolio management so they can be sure their managers are doing their homework and bringing the best thinking to bear on the management of their assets. ***Stay tuned!***