Using a Monte Carlo Analysis to Plan with Confidence

If you've received a Portfolio Analysis and Recommendations or Financial Analysis and Recommendations from MOSAIC in recent months, the odds are pretty good that you've seen a Monte Carlo simulation in those pages. And if you're already familiar with Monte Carlo analyses, we hope you'll forgive the pun.

Monte Carlo methods use probability distributions (the odds of occurrence of different possible events) to generate an array of potential outcomes. These tools have a wide range of applications in physics, engineering, insurance, artificial intelligence, and financial planning.

Financial planners often use Monte Carlo simulators to see what might happen to investments over a multi-year horizon.

For example, if you put 80% of your money in stocks and 20% in bonds, what would you expect to happen over the next ten years? Or twenty?

Taking a back-of-the envelope approach, you could assume that stocks will return 10% and bonds will earn 3%. You'd then predict a return of 8.6%:

Stock weight x stock return + bond weight x bond return = portfolio return

       (80% x 10%)   +   (20% x 3%)   = 8.6%

If only it were that simple! Although stocks may produce long-term gains around 10%, they can also bounce around quite a bit. For example, the S&P 500 Index dropped 37% in 2008 but was up over 26% in 2009. And though the returns get smoother when you look at longer horizons, there have been some 10-year periods when stocks were up 17% *annually* (1982–1991) and others when stocks posted modest losses over 10 years (2000–2009).

Although bonds gyrate a lot less than stocks, they can also have bad years (most recently in 2013 and 2018). Given the number of factors driving stock and bond prices—economic growth, interest rates, inflation, political factors, and market sentiment—it's very difficult to predict how those markets will perform over a given horizon.

While we can't say with certainty what *will* happen in stock and bond markets, we have 90 years of solid data on what *has* happened to them. We can apply this information to project what *might* happen to a portfolio with various degrees of confidence.

In the case of an 80% stock / 20% bond portfolio, we can reasonably say that it will produce an average expected return of 8.4%, given the long-term return on stocks (about 10%) and the interest rate on bonds (about 3%) today. We can also anticipate that this portfolio will move around with a standard deviation of 15.8% every year, given historical experience.

The standard deviation measures how much higher or lower the return in a single year might be versus the average. A minus-one-standard-deviation move in our portfolio would be:

Average Return – 1 Standard Deviation = -1 Standard Deviation Return

    8.4%   –   15.8%   = -7.4%

A plus-one-standard-deviation move in our portfolio would be:

Average Return + 1 Standard Deviation = +1 Standard Deviation Return

    8.4%   +   15.8%   = 24.2%

There's a 68% chance that the portfolio return will be within this one-standard deviation range within a given year, and a 95% chance that the portfolio will be within two standard deviations (-23.2% on the low side and 40% on the high side).

Putting these assumptions into a Monte Carlo simulator, we generate a spectrum of 1,000 possible returns over the next 20 years. Over time, the extremely high returns (over 40%) and exceptionally low returns (below -20%) offset each other:

Possible Returns of 80% Stock / 20% Bond Portfolio Over 20 Years

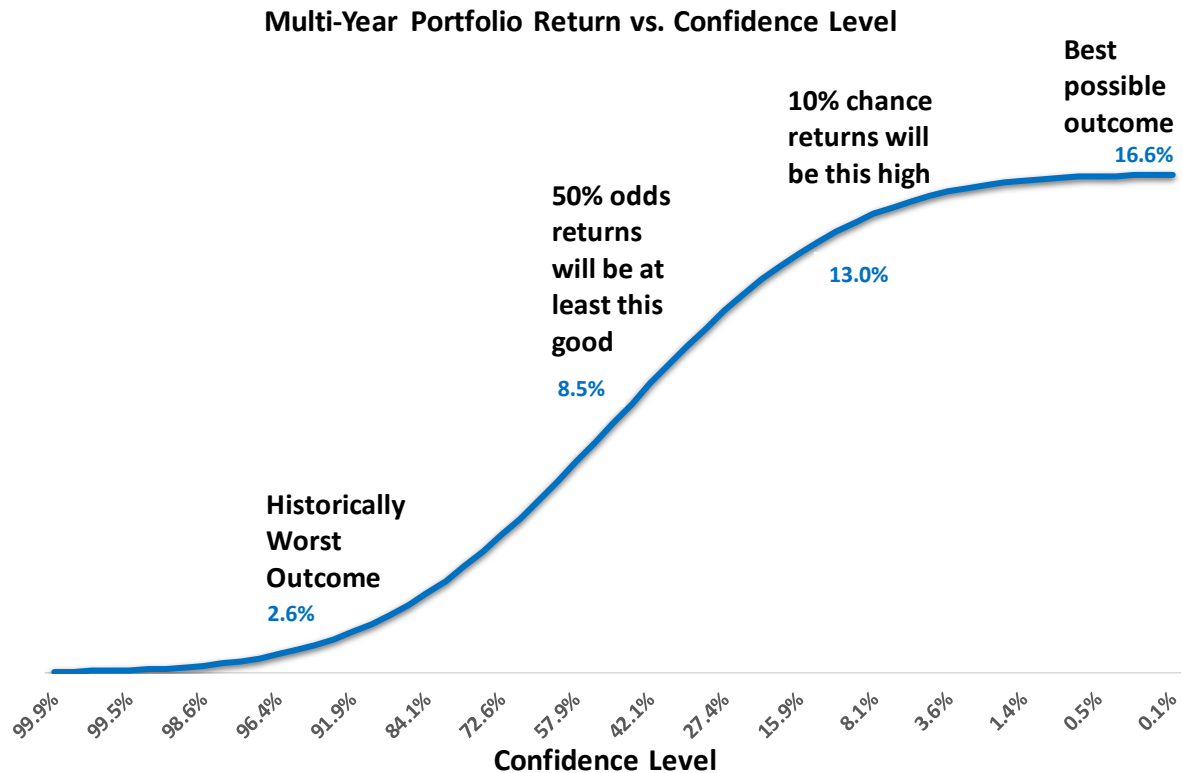| Return Percentile	Confidence Level	Annualized Return	
99th	1%	16.6%	← As Good As It Gets
95th	5%	14.3%	
90th	10%	13.0%	
75th	25%	10.9%	
50th	50%	8.5%	← Baseline Expectation
25th	75%	5.7%	
10th	90%	3.8%	
5th	95%	2.6%	← Historically Worst Outcome
1st	99%	0.3%	

The 50th percentile return is projected to be 8.5%, which is very close to the long-run 8.4% average. We can say with a 50% degree of confidence that the portfolio return will be 8.5% or higher (ignoring taxes and fees) over the next 20 years.

At the 90th percentile, the return is a hefty 13.0%. However, we can only say returns will be this high with a 10% degree of confidence.

If things don't go as well, the portfolio may only post a 10th percentile return of 3.8%. However, we can say with a 90% degree of confidence that this won't happen.

Looking at the lowest-percentile return might make you wince. "Only 0.3% annual returns over 20 years?! Is that even possible?" Statistically, yes. Historically, no. The simulation—like a roulette wheel—doesn't consider what happened in the previous year when it makes a guess as to what will happen in the next one.

In the stock market, however, returns reflect recent history. Fantastic runs like 1995–1999 are usually followed by mediocre or lousy ones (2000–2002) and vice versa. So while a roulette wheel has about a 1-in-20 chance of coming up red four times in a row, it's much harder for the stock market to post four consecutive down years. (That's only ever happened once, during the Great Depression.)

Multi-Year Portfolio Return vs. Confidence Level

Best possible outcome
16.6%

10% chance returns will be this high
13.0%

50% odds returns will be at least this good
8.5%

Historically Worst Outcome
2.6%

Confidence Level: 99.9% 99.5% 98.6% 96.4% 91.9% 84.1% 72.6% 57.9% 42.1% 27.4% 15.9% 8.1% 3.6% 1.4% 0.5% 0.1%

Confidence Level

Essentially, the 5th percentile / 95% confidence level for a Monte Carlo simulation over ten years or more reflects "the worst that has ever happened." Accordingly, investors should consider how their retirement spending could be affected in those sorts of scenarios. And what if you live longer than you expected in retirement?

MOSAIC wants to help clients develop financial plans with a high degree of confidence. We often call this a "probability of success." Our purpose is to ensure that you can retire with a spending level that you can sustain until you live to be 100, even if the stock and bond markets aren't particularly cooperative. That is, we're helping you to manage the "tail risks" of lower returns and longer life expectancy.

Retirement planning is further complicated by the fact that traditional IRA's, Roth IRA's, and individual accounts each have different tax treatment and withdrawal regulations. Fortunately, our Monte Carlo tools incorporate capital gains rates, marginal income tax rates, and required minimum distributions to reflect these nuances.

No one can consistently predict what returns markets will give to investors. But with the right asset allocation and a disciplined savings and withdrawal strategy, a Monte Carlo analysis can ensure that you don't have to leave much of your retirement to chance.