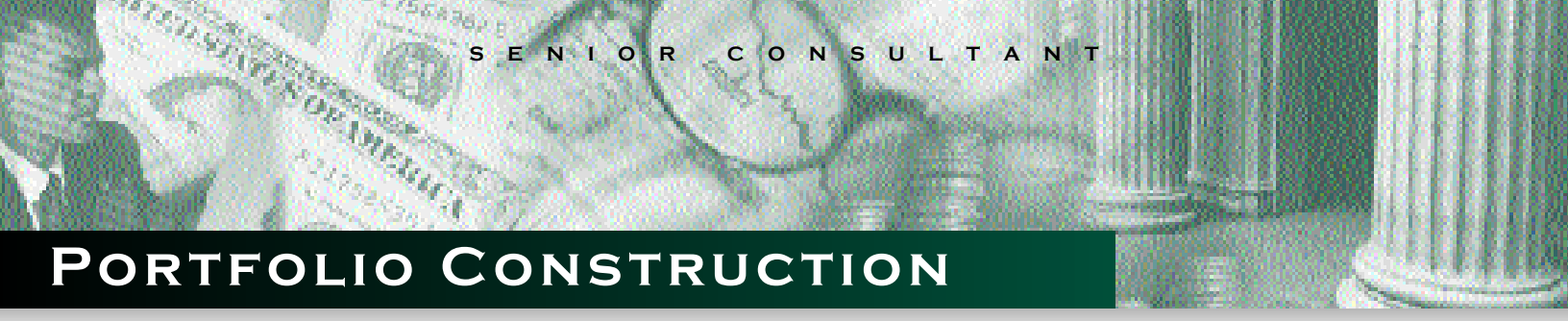


Portfolio Construction

Putting Monte Carlo Simulation Into Practice

Rex P. Macey

Rex Macey, CFA, CIMA heads product development for www.financeware.com and manages money using Monte Carlo simulation for Macey-Holland & Co., an Atlanta-based RIA. He can be reached by calling 404-812-7090 or by e-mail at rmacey@financeware.com.

Our firm has found a way to improve the asset allocation process and provide a competitive advantage to attract new clients by incorporating Monte Carlo simulation[1] (MCS).

Monte Carlo simulation, defined as the use of random sampling to estimate actual values, has helped clients become more comfortable with their strategic allocations and gain a better understanding of the trade-off between risk and return. At the same time, their focus shifts toward the longer view. For our part, we find it easier to arrive at the allocation decision. We also have a tool, that for the time being, provides us with a competitive advantage in attracting new clients.

Simulation has particular value when it comes to the problem of retirement planning, one of the most difficult in investing. Retirement planning is difficult simply because the investor does not know when he will die, and thus, the required rate of return is unknown. How can we select an asset allocation mix when the goal is unclear? To find out, we'll outline the conventional approach and address some of its weaknesses. Then we'll show how simulation overcomes these.

Imagine a hypothetical client, Mr. Jones who, at age 50, has $350,000 in retirement savings. He plans to save $10,000 every year before his retirement at age 70 and then withdraw $65,000 annually until death. The savings and withdrawals are to be adjusted by 3% inflation. For simplicity, we only have two investment mixes to consider: (1) an aggressive mix with a 10% average return and a 14% standard deviation, and (2) a moderate mix with a return and risk of 8% and 9%, respectively.

The challenge has always been to present the uncertainty of the future. Using averages camouflages the uncertainty. Simulation allows us to present the trade-off between risk and return and to incorporate risks that previously have been ignored.

The Conventional Approach

The conventional approach deals with uncertainty by being conservative. We might assume that Mr. Jones lives to be 91, 10 years past life expectancy. While the chance of living to life expectancy is 50%, the chance of Mr. Jones living to age 91 is about 13%.

The first problem with this conservative approach is the loss of credibility. When we present the plan to Mr. Jones, he understands that his living until 91 is unlikely. Since this assumption is unrealistic, he loses interest in the rest of the message.

We can calculate that he will meet his goal if he earns 7.85% in each of the next 41 years. Statistically we can estimate that the aggressive mix has a 72% probability of achieving the required return over 41 years. This compares to 44% for the moderate investment.[2] We can calculate probabilities ad nauseum using different time periods and also run several scenarios using different average returns to project portfolio values.

There are millions (actually more) of possible paths that a portfolio might take, as well as outcomes that might result. No one of these is likely to occur. Yet the conventional approach is to select one, or a few, on which a decision can be based. If we've used conservative assumptions (e.g., the client lives to 91 and gets below-average returns), the investor does not feel the case is realistic. Further, following the plan will likely cause him to save too much, spend too little and work too long. If we use an average case, then there is a significant chance of failure.

The conventional plan shows projections that are smooth because the same rate of return is used every year. When an investor's actual experience is erratic, which it's likely to be, the investor finds this disconcerting.

The conventional approach assumes a deterministic process (i.e., one without randomness). The motion of the planets around the sun is deterministic. Retirement planning is not a deterministic process. Rather, it is stochastic because the age at death and the rates of return are both random.

Where MCS Fits Into Our Process

We currently use MCS as a presentation and decision support tool. In the same way that a pilot might use a simulator to learn to deal with possible future experiences, we use simulation to

prepare an investor for future markets. Our goals are to:

1. have clients choose from among three to four strategic asset allocations that we are presenting,
2. help clients understand the risk and return of each,
3. focus the client's attention on long-term investment success,
4. prepare the client for the ups and downs he/she is likely to experience, and
5. instill in the client an appropriate level of confidence in his/her plans and in us.

At present, MCS does not tell us what to do nor does it improve our assumptions about future risk and return. It still suffers from "garbage-in, garbage-out." It only shows us what might happen if we make certain decisions, but we still have to make the decision.

An Approach Using Monte Carlo Simulation

Mr. Jones thinks of risk in terms of running out of money before he dies. He'd like to know the chance of success (or failure) for each investment. The conventional approach can't provide this information, but MCS can provide an estimate of the probability. We can now tell Mr. Jones that he has an 93% chance of success (i.e., a 7% chance of dying broke) with the aggressive mix and a 89% chance with the moderate mix.

There are infinite combinations of lifespans and returns that Mr. Jones might experience. We'll use MCS to sample 1,000 (or whatever number we choose) of these.

Like the conventional approach, we forecast a stream of cashflows (i.e., contributions and withdrawals) for Mr. Jones. We create 1,000 projections of future portfolio values using these cashflows. Whereas the conventional approach uses a single return each year, a Monte Carlo simulation can randomly vary each year's return based on a specified average and standard deviation. This allows us to capture two types of risk: (1) the investment risk which we define as the uncertainty related to what the average return will be and (2) the timing risk which is the uncertainty related to the order in which returns are experienced. Investment risk is impacted by the fact that while we are drawing from a population with a specified average, nothing assures us that our sample will have the same average as that of the population. When weighing timing risk in the face of cashflows, investors are better off if they experience higher returns when they have more assets invested and more time.

In addition, we are able to model mortality risk. Whereas a conventional approach uses a single specified age at death, Monte Carlo simulation allows us to vary the age at death based on mortality tables suitable for the individual.

The result is 1,000 projections in which both the age at death and each year's return vary. These projections may be thought of as a random sample. The use of random sampling to estimate a value is called Monte Carlo simulation. A client succeeds in a projection if his or her objective is met. Mr. Jones succeeds if he dies while there is still money in his portfolio. The proportion of successes is an estimate of the investor's chance of success. Conversely, we can count the failures which are the projections in which he dies broke.

WHEREAS A CONVENTIONAL APPROACH USES A SINGLE SPECIFIED AGE AT DEATH, MONTE CARLO SIMULATION ALLOWS US TO VARY THE AGE AT DEATH BASED ON MORTALITY TABLES SUITABLE FOR THE INDIVIDUAL

In practice, we provide our clients with 1,000 projections for several (four at most) investments. The first thing we show them is the distribution of ages at death (see table labeled "Sample Output from Monte Carlo Simulation Program AASim"[3]). This always gets their attention. Showing the distribution of ages builds credibility in our model and in the firm, because clients understand that when they die is uncertain. Mr. Jones knows he might have only one more year to live or that he might live to be 107, but that age 80 is a more likely outcome. Our model reflects what clients already know. Since our model captures this uncertainty, clients are more likely to believe the returns and portfolio values. After we've discussed the distribution of ages at death, we point out the probabilities of success (93% and 89%, respectively). These values must be satisfactory to the client. If the probability of success is too low, then we must increase savings, reduce expenses or postpone retirement.

We then focus on the distribution of one-year results. We want to confirm that the client can accept the short-term fluctuations that may occur in the portfolio. With this one-page of results, we can get a client to choose an investment mix.

Are The Results From MCS Difficult To Present?

Many investment consultants question how difficult it is to present the results of such an advanced mathematical technique. We use MCS primarily because it makes presenting investment choices easier. We do not find it necessary to discuss random sampling. But then, we have never had to explain quadratic optimization or lognormal distributions when presenting an efficient frontier to a client. Clients understand a 93% probability of success and a 7% chance of dying broke. They also understand worst, median and best-case outcomes over 1-, 5- and 10-year periods when they are measured in today's dollars. MCS allows us to present information in terms the client understands, namely the probability of success and portfolio values. We are freed from percentage rates of return and standard deviation.

What About Compliance?

Our opinion is that MCS is compliance-friendly. Look at the sample output and note how wide the range of results are. We are also showing that there is the possibility of failure. In essence, MCS lets us illustrate risk in terms meaningful to clients. The presentation of risk is generally favored by those who are concerned with compliance issues.

What MCS Doesn't Do

We still have to create portfolios to evaluate MCS. In our practice, we start with an optimizer to construct efficient frontiers. From these, we create model portfolios that are near efficient but which are more diversified. We select three to show the client and compare them with his or her current portfo-

Ph 804-795-1642 ■ Fax 804-795-7703

lio. MCS did not help us construct the model portfolios, but it does help us to select one.

The Future Of MCS

We adopted MCS because the investment world is full of uncertainty, and MCS is a superior tool to model that uncertainty. Consultants' concerns about its complexity are due to its newness, not its difficulty. It requires a level of computing power that only became widely available recently.

We plan to continue to improve our models so they more accurately reflect the real world. We will use MCS to handle the complexity of dynamic strategies, e.g., where the asset allocation and/or the spending policy changes during the projection in response to the path the projection is taking. We will also begin to study and recommend combinations of investment and spending strategies that span a lifetime.

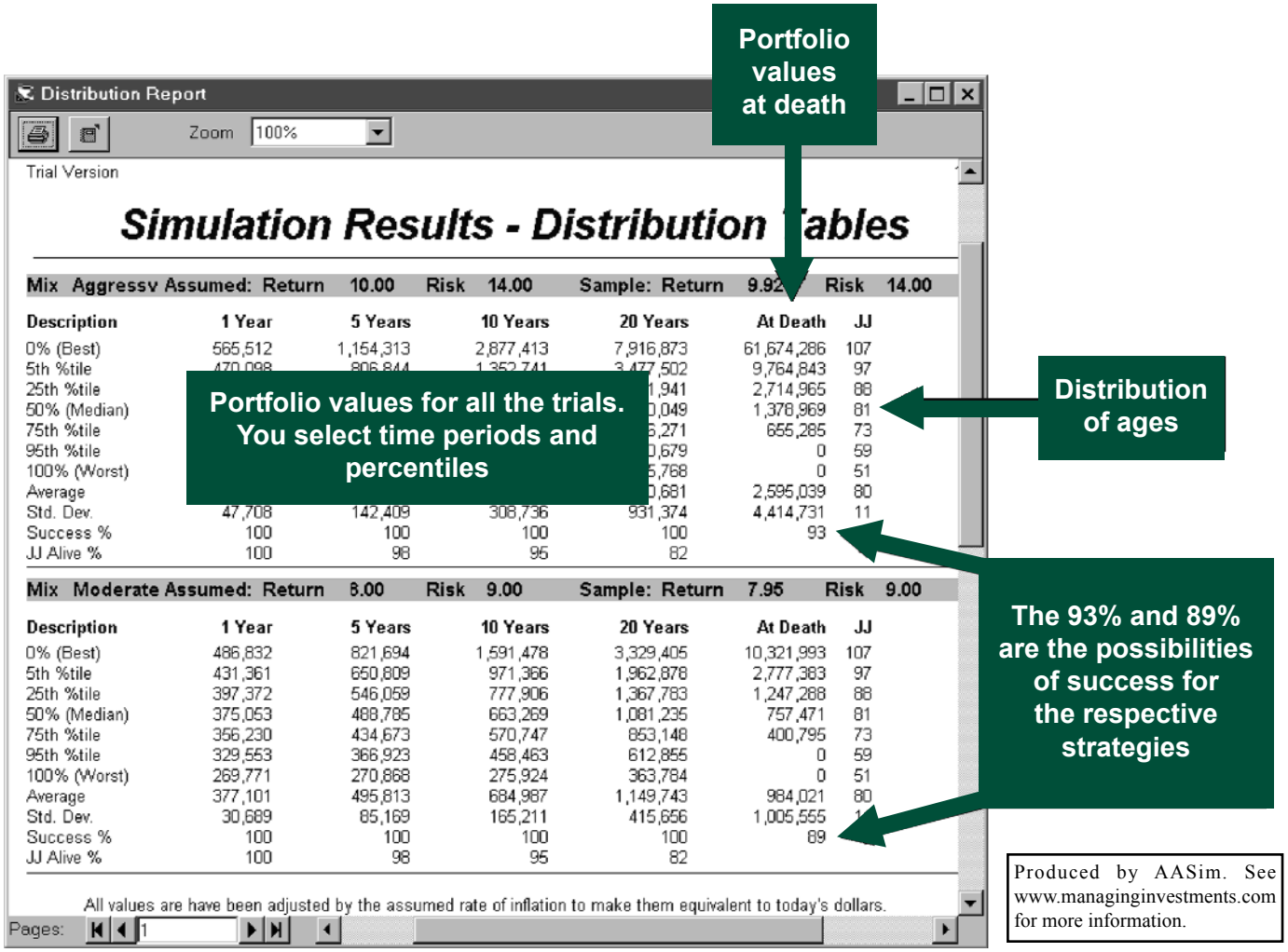
Notes:

[1]Monte Carlo Simulation is the use of random sampling to estimate actual values.

[2]We are assuming lognormal distributions of wealth relatives, i.e., 1+ rate of return. The 10% and 8% averages are arithmetic average returns. The median returns for the aggressive and moderate mixes would be 9.1% and 7.6%, respectively.

[3]For information on AASim, the software used to generate this, visit http://www.managinginvestments.com

Sample Output from Monte Carlo Simulation Program AASim



Mix Aggressv Assumed: Return 10.00 Risk 14.00 Sample: Return 9.92 Risk 14.00

Description	1 Year	5 Years	10 Years	20 Years	At Death	JJ
0% (Best)	565,512	1,154,313	2,877,413	7,916,873	61,674,286	107
5th %tile	470,098	806,844	1,352,741	3,477,502	9,764,843	97
25th %tile				1,941	2,714,965	88
50% (Median)				0,049	1,378,969	81
75th %tile				6,271	655,285	73
95th %tile				0,679	0	59
100% (Worst)				5,768	0	51
Average				0,681	2,595,039	80
Std. Dev.	47,708	142,409	308,736	931,374	4,414,731	11
Success %	100	100	100	100	93	
JJ Alive %	100	98	95	82		

Mix Moderate Assumed: Return 8.00 Risk 9.00 Sample: Return 7.95 Risk 9.00

Description	1 Year	5 Years	10 Years	20 Years	At Death	JJ
0% (Best)	486,832	821,694	1,591,478	3,329,405	10,321,993	107
5th %tile	431,361	650,809	971,366	1,962,878	2,777,383	97
25th %tile	397,372	546,059	777,906	1,367,783	1,247,288	88
50% (Median)	375,053	488,785	663,269	1,081,235	757,471	81
75th %tile	356,230	434,673	570,747	853,148	400,795	73
95th %tile	329,553	366,923	458,463	612,855	0	59
100% (Worst)	269,771	270,868	275,924	363,784	0	51
Average	377,101	495,813	684,987	1,149,743	984,021	80
Std. Dev.	30,689	85,169	165,211	415,656	1,005,555	1
Success %	100	100	100	100	89	
JJ Alive %	100	98	95	82		

This table summarizes 1,000 trials. The most important number is in the *Success %* row under the *At Death* column. We can see that Mr. Jones met his objective 93% of the time with the Aggressive strategy and 89% with the Moderate strategy.

The *0% Best* row shows the best outcome of all the trials. In no trials did Mr. Jones' portfolio exceed $565,512 after one year ($1,154,313 after five years, etc.). In 5% of the trials, the value exceeded $470,098 ($806,844 after five years, etc.). The *At Death* column shows the portfolio value at death. You may set the time periods and percentiles to display on the Options tab of the input screen. The distribution of the ages at death is shown under the *JJ* (the initials of the investor) column.

The *Success %* row shows the percentage of the trials in which the value of the portfolio exceeded the target value. The *JJ Alive %* row shows the percentage of trials in which Mr. Jones lived for that time period. The shaded row shows the average and standard deviation of the assumed (input) returns with those of the randomly drawn returns.

Ph 804-795-1642 ■ Fax 804-795-7703