

## Investing as a Game of Chance? Insights on Monte Carlo Simulation and Your Portfolio

*No matter how sound their strategy, investors need to acknowledge that investment returns, not unlike roulette wheels or dice rolls, exhibit random behavior. Monte Carlo Simulation can be an effective tool for incorporating this reality into your investment plan.*

It may be disconcerting to liken your investment strategy to the games of chance popular in the casinos of Monte Carlo, but it would not be an entirely inaccurate comparison. While it's common in financial planning to focus on averages, for instance 10% as a reasonable assumption for equity returns over a long-term horizon, a simple average does not take into account the *path* of those returns year-by-year. For example, the average annual return of the S&P 500 Index between 1960 and 2005 was just over 10%, but was 10% a "typical" return in any of those individual years? You might be surprised to learn that in only 5 of those 40 years did the annual return fall between 7 and 14%. Just like rolling a die, where you know that a number between 1 and 6 will come up but don't know which one on any particular roll, predicting the return on your investment portfolio in a given year is a highly uncertain exercise.

So what are the implications of this phenomenon for investors? If we could agree not to touch our portfolio for the next 30 years, assuming a 10% average return at the end of our investment period doesn't seem so unrealistic. But how typical is that scenario? Most investors need to draw on their investments periodically to cover living and other expenses. And where there are inflows or outflows, the path-dependency of investment returns becomes a critical factor in the likelihood of an investor ultimately meeting his or her long-term return target. Similarly, at what point in the path of an investment's lifetime a very bad year happens to fall can also have a meaningful impact on the investor's long-term results.

A simple example can help illustrate this point: suppose you have a \$100 investment on which you assume a 10% average annual return. In two years, under this assumption, your portfolio will have grown to \$121. But what if you actually earn -2% in year 1 and 22% in year 2? Your average return is still 10%, but your portfolio value will grow to only \$119.56 at the end of the 2-year period. Extrapolate this concept over a long period of time and introduce varying annual return figures, and the results can be staggering (See *Example: Timing is Everything*). In order to increase the odds of meeting your goals, *your financial plan has to take into account the reality that the factors contributing to your ultimate success will be highly variable over time*. Let's now turn to how this can be accomplished.

### Enter Monte Carlo Simulation

Monte Carlo Simulation ("MCS") is a statistical technique that estimates the probability of meeting future targets or goals. Polish-born mathematician Stanislaw Ulam, who worked on the United States' Manhattan Project during World War II, is credited with its creation.

In the context of financial planning, MCS most often is used to estimate the likelihood of meeting investment goals by accounting for the variability in various underlying assumptions – for example capital market returns, interest rates, inflation, spending and contribution levels, potential income sources, asset class correlations, and life expectancies.

At Gerstein Fisher, MCS plays an integral role in the planning process we work through with our clients, allowing us to assemble the portfolio with the highest likelihood of meeting their objectives subject to their return requirements, their tolerance for risk, and their lifestyle (i.e. spending) needs.

Based upon extensive proprietary and industry research and using expected return and risk (standard deviation) targets agreed upon with our clients as constraints, we use MCS to execute thousands of trials to simulate the expected results for a client's financial strategy. The simulation, run on a computer, randomly generates values for uncertain variables like equity and bond returns or interest rates for each trial to come up with a series of potential possible outcomes. The result is a certain percentage "confidence level" that the client will meet his or her return target given an existing portfolio structure. For example, if the simulation runs 1,000 trials and out of that, the client achieves her goals in 750 of them, that represents a 75% confidence level.

If our analysis results in a confidence level that is too low for a client's comfort, we work to adjust such variables as asset allocation, retirement age, spending needs, expected contributions, etc. in order to arrive at a higher confidence level. For instance, a client's spending level may need to be ratcheted down to reduce the number of "failed" trials. Alternatively, we may end up with a confidence level that is too high: for example, it may look likely that the client could leave a good deal of money

on the table upon death. In this scenario, we may either reduce portfolio risk and required return or suggest the client spends more. This exercise helps us to calculate the required return to fund the client’s liabilities and then engineer the portfolio to those constraints.

MCS can be used for far more than estimating a probability of meeting an investor’s objectives. For instance, the process can be “reverse-engineered” to find out, for a given confidence level, what level of spending a client’s portfolio can support. Similarly, we can use it to determine how long our portfolio assets are likely to last (at a given confidence level) based on a certain spending level.

### Lessons from Monte Carlo

At Gerstein Fisher, we have relied on Monte Carlo Simulation for close to 10 years, and after literally millions of trials on hundreds of client portfolios, we’ve learned a few things that we think investors should bear in mind when thinking about MCS:

- Diversification matters:** Our practical experience using MCS reinforces some of the key tenets of our investment philosophy: that constructing well-diversified portfolios with a healthy mix of assets, ideally some with very low or negative correlations to the portfolio, serves to minimize volatility and produce more consistent returns and higher probabilities of success.
- MCS requires skill and judgment:** We’ve also learned that, as is true of any sophisticated financial planning tool, the usefulness of MCS is highly dependent on the quality of the inputs a financial advisor uses in setting up the simulation. (Maybe you’re familiar with the term “garbage in, garbage out?”) For the confidence number to mean anything, our capital markets assumptions must be neither too optimistic nor too pessimistic. If we only use market returns from a period of relative market strength, for instance, an 80% confidence level might not be so compelling. When we consider a wider range of possibilities, more of them negative, this outcome suddenly looks a lot better.

- MCS is not a “silver bullet”:** We also have learned that it’s important to help our clients understand that MCS itself is not an exercise in certainty, but rather in probability or possibility – and that it also is an exercise in tradeoffs. In most instances, the portfolio that results in the *highest possible* confidence level would actually require that a client sacrifice too much in the way of current spending or gifting to children, or result in higher-risk portfolios than required. Much of the work we do with our clients is in interpreting the results of these simulations and helping them to navigate these tradeoffs and arrive at a comfortable confidence level given all of these factors.

### Example: Timing is Everything

Suppose you are presented with two investments with the following characteristics:

	Investment A	Investment B
<b>30 Year Average Return:</b>	6.0%	8.1%
<b>Number of Years It Outperformed</b>	1	29
<b>Number of Years It Underperformed</b>	29	1
<b>Best Return In Any Year</b>	20%	25%
<b>Worst Return in Any Year</b>	-35%	-7%
<b>Standard Deviation</b>	8.1%	4.21%

Source: Financeware, Inc., David B. Loeper, CIMA

Based on this information alone, most of us would pretty quickly choose Investment B and wonder why anyone would even *consider* Investment A. After all, Investment B has a higher average return, lower standard deviation, and it outperformed Investment A in 29 out of 30 years. But the following table shows how important the timing of those returns is to the ultimate portfolio value of each investment.

"Investment A"					"Investment B"				
Year	Return in %	Return in \$	Contribution/Withdrawal	Portfolio Value	Year	Return in %	Return in \$	Contribution/Withdrawal	Portfolio Value
				\$100					\$100
1	7%	\$7	-\$7	\$100	1	8%	\$8	-\$7	\$101
<b>2</b>	<b>20%</b>	<b>\$20</b>	<b>-\$7</b>	<b>\$113</b>	<b>2</b>	<b>-7%</b>	<b>-\$7</b>	<b>-\$7</b>	<b>\$87</b>
3	7%	\$8	-\$7	\$114	3	8%	\$7	-\$7	\$87
4	7%	\$8	-\$7	\$115	4	8%	\$7	-\$7	\$87
5	7%	\$8	-\$7	\$116	5	8%	\$7	-\$7	\$87
6	7%	\$8	-\$7	\$117	6	8%	\$7	-\$7	\$87
7	7%	\$8	-\$7	\$118	7	8%	\$7	-\$7	\$87
8	7%	\$8	-\$7	\$120	8	8%	\$7	-\$7	\$87
9	7%	\$8	-\$7	\$121	9	8%	\$7	-\$7	\$87
10	7%	\$8	-\$7	\$122	10	8%	\$7	-\$7	\$86
11	7%	\$9	-\$7	\$124	11	8%	\$7	-\$7	\$86
12	7%	\$9	-\$7	\$126	12	8%	\$7	-\$7	\$86
13	7%	\$9	-\$7	\$127	13	8%	\$7	-\$7	\$86
14	7%	\$9	-\$7	\$129	14	8%	\$7	-\$7	\$86
15	7%	\$9	-\$7	\$131	15	8%	\$7	-\$7	\$86
16	7%	\$9	-\$7	\$134	16	8%	\$7	-\$7	\$86
17	7%	\$9	-\$7	\$136	17	8%	\$7	-\$7	\$86
18	7%	\$10	-\$7	\$138	18	8%	\$7	-\$7	\$86
19	7%	\$10	-\$7	\$141	19	8%	\$7	-\$7	\$85
20	7%	\$10	-\$7	\$144	20	8%	\$7	-\$7	\$85
21	7%	\$10	-\$7	\$147	21	8%	\$7	-\$7	\$85
22	7%	\$10	-\$7	\$150	22	8%	\$7	-\$7	\$85
23	7%	\$11	-\$7	\$154	23	8%	\$7	-\$7	\$85
24	7%	\$11	-\$7	\$158	24	8%	\$7	-\$7	\$84
25	7%	\$11	-\$7	\$162	25	8%	\$7	-\$7	\$84
26	7%	\$11	-\$7	\$166	26	8%	\$7	-\$7	\$84
27	7%	\$12	-\$7	\$171	27	8%	\$7	-\$7	\$84
28	7%	\$12	-\$7	\$175	28	8%	\$7	-\$7	\$83
29	7%	\$12	-\$7	\$181	29	8%	\$7	-\$7	\$83
<b>30</b>	<b>-35%</b>	<b>-\$63</b>	<b>-\$7</b>	<b>\$111</b>	<b>30</b>	<b>25%</b>	<b>\$21</b>	<b>-\$7</b>	<b>\$97</b>
	<b>6.0%</b>	<b>Average</b>				<b>8.1%</b>	<b>Average</b>		
	<b>8.10%</b>	<b>Standard Deviation</b>				<b>4.21%</b>	<b>Standard Deviation</b>		
	<b>-35%</b>	<b>Worst Year</b>				<b>-7%</b>	<b>Worst Year</b>		
	<b>20%</b>	<b>Best Year</b>				<b>25%</b>	<b>Best Year</b>		

Source: Financeware, Inc., David B. Loeper, CIMA

This example should help highlight the impact of even a small amount of uncertainty (that Investment B would underperform in only 1 of 30 years) on investment results – and thus the usefulness of an exercise like MCS which takes these and other scenarios into account as possible outcomes.

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