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Monte Carlo Model: Is it Good for *Your* Client?

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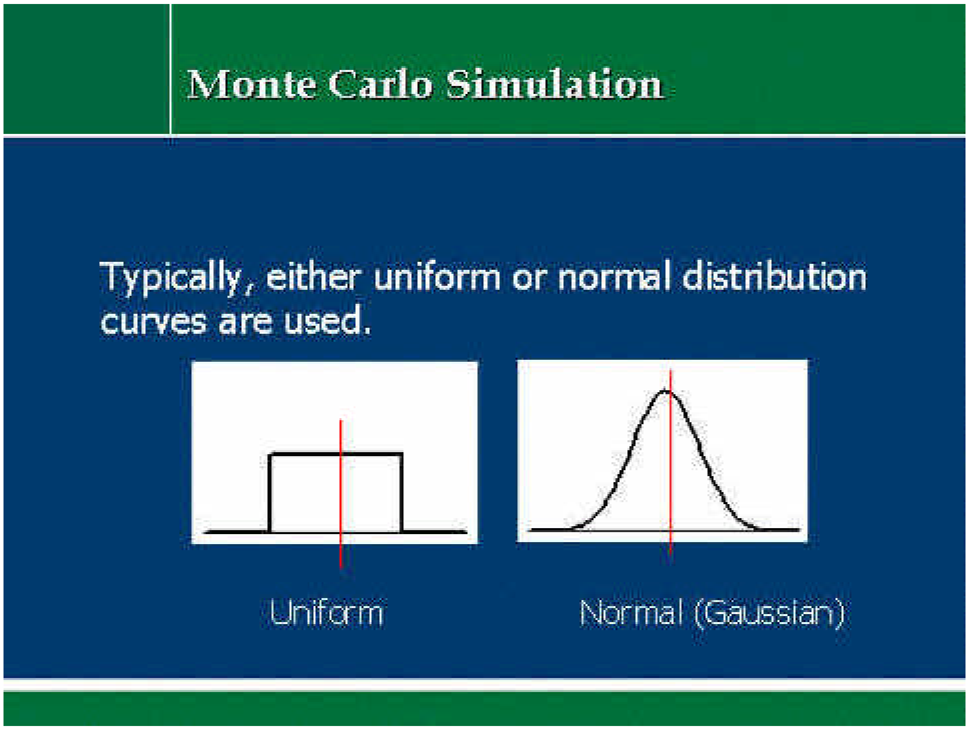
The Monte Carlo simulators are becoming more and more popular. How good are their forecasts? Better learn their flaws before it is too late.

Since the last bear market, more and more advisors are switching from the standard retirement calculators to Monte Carlo (MC) simulators to forecast portfolio assets values. What makes the MC different from a standard retirement calculator is that it adds random fluctuations to a steady growth of the portfolio. The user selects a base line (assumed base growth rate) and a standard deviation from that base line. The model then runs thousands (or millions, if you choose so) of projections by randomly varying this base line. Finally, it reports range and probability of these projections.

MC model is a step forward from the standard retirement calculator. It brings into the open the reality that markets do not grow on a straight line. However, that does not mean that we should ignore its shortcomings.

FLAW #1: The first flaw of the MC is how it generates randomness. The randomness is generated using a distribution curve. There are many types of distribution curves, such as: Normal, Lognormal, Triangular, Uniform, Binomial, Exponential, and Geometric to name a few. Which one fits best to retirement planning? Which one is best for accumulation planning? Which distribution curve does your MC simulator use? These are some of the important questions to ask.

Figure 1: Typical Distribution Curves:



The uniform distribution curve generates random numbers with equal frequency. For example if the base line is 8% and the range is between–16% and +16%, then the probability of a 15% growth rate projection is the same as 5%.

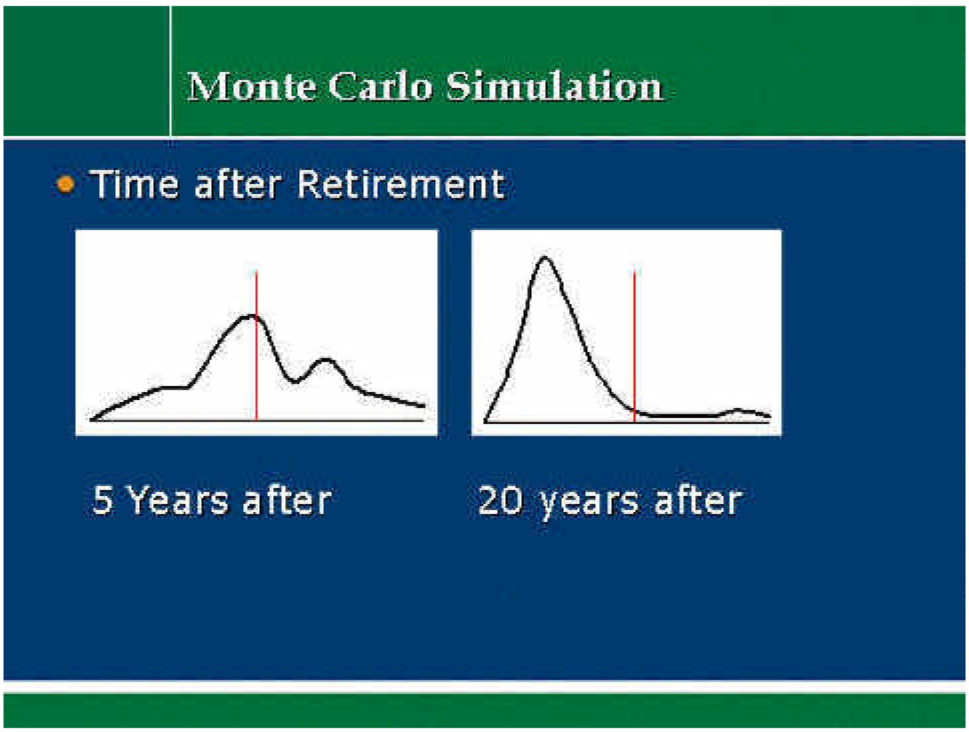
The normal (also known as the Gaussian, or the bell curve) is based on generating more of the numbers that are closer to the base line and fewer that are further from the base line. For example if the base line is 8% and the stated range is between–16% and +16%, then a 10% growth rate is forecasted a lot more often than a 3% growth rate.

THE REALITY: In real life, the distribution curve is significantly different than these idealized distribution curves. Not only that, the market history shows that the distribution curve changes its shape over time. Some of these changes are: flattening of the curve, shifting towards left, the tail ends "flapping". Deviations from normal distribution curve create higher incidences of deviance from real life outcomes.

Many factors affect these deviations: the amount of withdrawal as a percentage of the assets, time passed since the beginning of retirement, the choice of asset allocation, dedication strategy and rebalancing methods, to name a few. Figure 2 shows the actual distribution curve of a portfolio after five years and after twenty years. As time passed, the shape of the distribution curve changed significantly.

When the distribution curve used in the MC model does not match the reality over the **entire** retirement time period, the resulting simulations will be significantly different from actual market history.

Figure 2: Actual probability distribution curves for a distribution portfolio 5 and 20 years after retirement



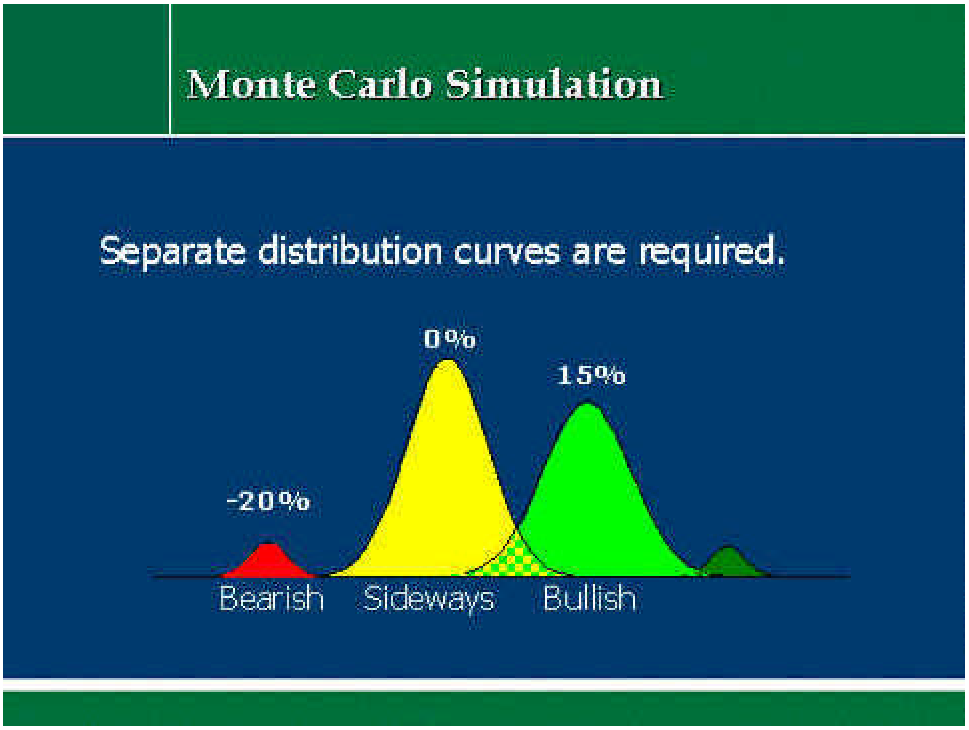
FLAW #2: The second flaw of MC is that the outcomes it generates are random. It ignores the effects of secular trends.

THE REALITY: When we look at history, we observe that markets are random in the short term, cyclical in the mid-term, and trending in the long term as depicted in Figure 3.

Figure 3:Secular trends

In reality, for a proper simulation model, we must distinguish the three separate long-term trend regimes: bullish, sideways and bearish. Therefore, you need at least three separate distribution curves working at different times, for long periods of time, as depicted in Figure 4. If the long-term trend is bullish or sideways, the outcomes may be "stuck" within that particular distribution curve for up to 20 years.

Figure 4: Required distribution curves to reflect the market behavior:



Consequently, what happens in practice is, users of MC increase the range of outcomes, say from ±15% to ±30%. This broad-brushes all trends to cover the entire range. Doing so only masks this problem, it does not solve it. MC simulation is based on statistical randomness around a predefined straight line. Increasing the envelope of outcomes does not make it more accurate. If the model does not fit well, then running ten million simulations instead of ten thousand does not make the results more accurate.

FLAW #3: The third flaw of MC is that ignores the correlation between the market events.

THE REALITY: When we study the market history, the sequence of market events are not random but they are correlated: For example a high inflation environment eventually causes the short term interest rates to rise, which can have bearish effects on the stock and bonds, or vice versa. Random treatment of different asset classes and inflation is not congruent with what happens in real life. Yet, that is exactly what happens in a MC simulation, it will pick randomly a high inflation and high equity growth rate and bond returns **all in the same run**.

FLAW #4: The fourth flaw of MC is the unrealistic sequence of outcomes.

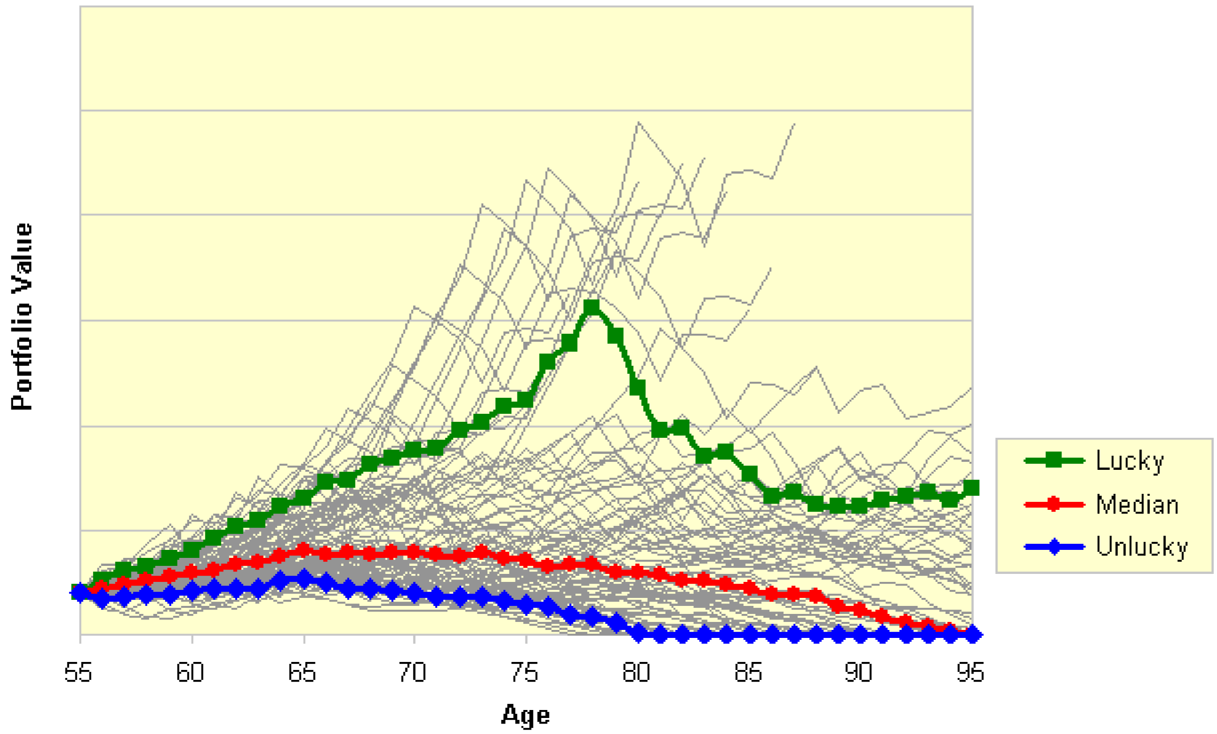
THE REALITY: In real life, usually during the last one third of a secular bull trend, good news begets more good news. The index moves up higher just because many bet that it will continue moving higher. On the other hand, when a bad bear market starts, bad news begets more bad news. These create what is known as "fat" tail ends on the distribution curve. Markets digest the speculative energy of the bull runs in one of the two ways: Either a sharp sell-off -like high waterfalls- that may last 3-4 years (1929), or multi-cycle sideways market, - like a meandering river- that may last as much as 20 years. That is what happened since the recorded market history.

MC simulators ignore this effect. They will rarely produce multi-year, back-to-back "streak" of multiple bear or bull outcomes, as happens in real life.

This flaw is most obvious when we look at distribution (retirement) portfolios using actual market history. The median line, where half of the portfolios do better and half do worse, is a lot closer to the bottom decile (bottom 10%) then to the top decile (top 10%), even though the probability of a top decile outcome is identical to the probability of a bottom decile.

In other words, the path to unlucky outcome (bottom decile) is a lot shorter than the path to a lucky outcome (top decile) after retirement, an effect that must not be ignored. It takes only a little push of small, adverse events to turn a "median" portfolio into an "unlucky" one, however, it takes a whole lot of large, favorable events to turn a "median" portfolio into a "lucky" one.

Figure 5: The Actual Market History: Median, Lucky and Unlucky Outcomes during retirement:



I compared the outcomes of a MC simulator with actual market history using the same case. The following table compares the probability of depletion:

	Probability of Depletion	
Years after Retirement	MC Simulation	Actual History
10	0%	0%
15	1%	3%
20	14%	36%
25	37%	68%
30	55%	86%

In the final analysis, most Monte Carlo simulations forecast outcomes that are too optimistic. That is the reason why I designed and developed the Otar Retirement Calculator which is based on actual market history. But that is another story.

A Better Mousetrap:

If you insist on using a simulator instead of actual historical data, then at least use a better simulator. For that, you need to start with the bigger picture. Here is what the US markets did during the last century:

Table 1: The Bigger Picture, Secular Trends:

Trend		Average Annual DJIA Growth	Average Annual Inflation	Length, years
All Trends	1900-1999	**7.7%**	**3.3%**	
Secular Sideways:		**2.4%**	**5.6%**	
	1900 – 1920	4.2%	4.8%	21
	1937 – 1948	1.4%	4.8%	12
	1966 – 1981	0.8%	7.1%	16
Secular Bull:		**15.0%**	**1.8%**	
	1921 – 1928	20.6%	-1.5%	8
	1949 – 1965	11.5%	1.7%	17
	1982 – 1999	15.9%	3.3%	18
Secular Bear:		**-31.7%**	**-6.4%**	
	1929 – 1932	-31.7%	-6.4%	4
Other:				
Cyclical Bull	1933 - 1936	33.5%	1.7%	4

Based on this picture, here are the basic tenets of the better MC simulator for the US markets:

- A secular bull or sideways market lasted as long as 20 year, a secular bear market lasted 4 years

- Each secular bull market was followed by a secular bear or sideways market
- Approximately, the annual average annual growth rate was 15% during a secular bull market, 2% during a sideways market, and negative 30% during a secular bear
- Approximately, the average annual inflation was 2% during a secular bull market, 6% during a sideways market, and negative 6% during a secular bear

A Two-Layer Monte Carlo Simulator:

To include the effects of the secular trends, the simulator ought to have two layers. Lets' call this an MC2 simulator. The first layer selects a secular trend at random. The only rule at this first level is that the same secular trend cannot be repeated: A secular bull trend can only be followed by a secular sideways trend or a secular bear trend. A secular bear trend can only be followed by a secular sideways trend or a secular bull trend. A secular sideways trend can only be followed by a secular bullish or bearish trend. Once a secular trend is selected, its duration is also set for the simulation: A secular bullish or sideways trend lasts 20 years, a secular bear market lasts 4 years.

The second layer of the simulator is identical to what is being used today, however, with different base rates for each secular trend. Use following base assumed growth rate and inflation:

- If the first layer of simulation is a secular bull trend, then the second layer is set to: Average growth rate: 15% annually, ±20%. Inflation: 2% annually, ±1%. Length of time: 20 years
- If the first layer of simulation is a secular sideways trend, then the second layer is set to: Average growth rate: 2% annually, ±20%. Inflation: 6% annually, ±2%. Length of time: 20 years
- If the first layer of simulation is a secular bear trend, then the second layer is set to: Average growth rate: -30% annually, ±20%. Inflation: -6% annually, ±2%, time horizon 4 years

This simulator reflects the US equity market history better than what is in current use. Keep in mind that markets other than DJIA and S&P500 have different rules based on their own historic experience.

This MC2 model will create simulations that will reflect the actual market behavior significantly better. It is available for downloading for free at my website, www.retirementoptimizer.com

Jim Otar is a financial planner, a professional engineer, a market technician, a financial writer and the founder of retirementoptimizer.com. His past articles on retirement planning won the CFP Board Article Awards in 2001 and 2002. He lives and works in Thornhill, Canada, (905) 889-7170, jimotar@rogers.com