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Limitations of Monte Carlo Analysis

A roundtable discussion with

Jim Sandidge, JD, Derek Tharp, PhD, CFP®, and Robert Powell, CFP®



INVESTMENTS & WEALTH INSTITUTE®

Limitations of Monte Carlo Analysis

Investments & Wealth Monitor wanted to examine some of the limitations of Monte Carlo analysis. As such, we conducted a round-table discussion with three industry leaders.

Jim Sandidge, JD, is principal of The Sandidge Group LLC. He is the author of “Odds Are Retirees Don’t Care About the Odds, which appeared in the Retirement Management Journal.

Derek Tharp, PhD, CFP®, is an assistant professor of finance at the University of Maine School of Business, lead researcher at Kitces.com, and the founder of Conscious Capital.

Robert Powell, CFP®, is editor of the Retirement Management Journal, and editor and publisher of Retirement Daily on TheStreet.

Investments & Wealth Monitor Editorial Advisory Board Chair Tony Davidow, CIMA®, moderated the discussion.

Davidow: The wealth management industry has embraced Monte Carlo for financial modeling. Although it’s a valuable tool, it has certain inherent limitations, largely the stability of future returns, future income, and correlations. In fact, in today’s market environment most capital market assumptions are projecting dramatically lower returns, income is near generationally low levels, and correlations across most traditional asset classes remain elevated. Jim, I’ll



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start with you. What do we think the implications are if the future isn’t like the past?

Sandidge: Well, it’s a good question. I recently finished writing up some research I did, both scenario analysis as well as historical analysis. I applied a 50/50 portfolio with a 5-percent withdrawal, 3-percent increases, and a 1.5-percent annual fee, to every 25-year period going back to 1900. One of the things I did not find is that low bond yields were very predictive of success or failure for retirement income. If you look at the stretch 1940 through 1954, during those 15 years the 10-year Treasury yielded an average rate of 2.4 percent. If you look at the trailing 10 years through 2020, it was also 2.4 percent, and those are the lowest numbers I saw. But going back to that earlier stretch, when I looked at the retirement-income portfolios and applied that systematic approach to portfolios beginning with those 15 years, nine of them finished the 25th year with more than they began with. One, the worst one, finished with 43 percent of its original investment, and the others all finished with at least 50 percent of the original investment.

So I would argue that now is a comparable period in terms of rates. It was not a problem back then to generate sufficient cash flow starting with a 5-percent initial withdrawal, increasing at 3 percent a year. If you look at 2008, which was a very difficult year to retire, a 50/50 portfolio

lost 12.6 percent that year, but that’s the fourth-worst return I saw since 1900. You lost 12.6 percent, you take a 5-percent withdrawal at a 1.5-percent fee, you’re down 19 percent at the end of your first year. That’s tough to take, and you’re just hoping for good returns so you can recover, whether they come from dividends, interest, or capital gains.

Over the 10 years after that loss, yields were again 2.4 percent. The average annual return was 8.2 percent, which is pretty good but not exciting, and the portfolio had 81 percent of its principal at the end of the first year. At the end of the 11th year, it had 78 percent of its principal. So very little principal eroded in that 10-year period because, despite those low bond yields, you had nine straight years of positive returns.

What I found in looking at all these historical timeframes was that the driver, the core to solving retirement income, was negative returns. It wasn’t low bond yields. It wasn’t even low average annual returns. From 1900 to 1939, a 50/50 portfolio averaged 7.1 percent. Thirty-three of the portfolios beginning in those 40 time periods ran out of money when I applied the systematic withdrawal, so

obviously there was a very high failure rate. But when I created a scenario where you earn 7.1 percent every year with no negative years and apply that systematic approach, I finished the 25th year with 40 percent of my original investment. And if you skip cash-flow increases the first two years, I finished with 60 percent. So again, whether it's low bond yields or low average annual returns in general, I found that you could have success with a retirement-income portfolio if you're not burdened with negative returns and by actively managing cash flow.

Davidow: Derek, I wonder if maybe we can just take that discussion a step forward. If the future isn't going to be like the past, should you even use Monte Carlo and forward-looking capital market assumptions?

Tharp: Let's consider some forward-looking periods, maybe it's one decade or two decades, making some adjustments based on the current environment and projecting out using Monte Carlo. We could refine it with maybe a regime-based Monte Carlo approach, where we have one set of assumptions for the first period and then a second set of assumptions that are closer to long-term averages or what somebody expects would be the new long-term average. I would look at Monte Carlo as separate from the capital market assumptions. I wouldn't get rid of Monte Carlo just because the capital market assumption piece is hard to use. But as advisors, we should understand the limitations that come with that approach and how we should use it with clients.

Davidow: Bob, what are your views regarding Monte Carlo and adjusting the capital market assumptions? What are the implications if investors don't achieve the long-term historical average of the S&P, which is 10.2 percent? Virtually all the capital market assumptions that I have reviewed—JP Morgan, Goldman, Morgan Stanley, and BlackRock—are projecting traditional equity returns in the 4-5-percent range. And, as Jim just

pointed out, fixed income yields are well below their historical averages. What are the implications for meeting client needs over time?

Powell: Everything turns on the inputs. If your people are using the wrong assumptions, whether it's inflation rates or capital market assumptions, then the probability of failure rises. The probability of negative consequences due to that failure also rises. A lot also depends on the timing and the magnitude of those negative consequences. So you're rolling the dice if you're not using realistic assumptions. You need to identify a target probability of success, maybe portray high, medium, and low probabilities for your clients. Best case, worst case, probable case, giving a band of outcomes at some reasonable probability of success. Otherwise you're setting up yourself and your client for failure.

Davidow: Investors are going to need to recalibrate their retirement plans by retiring later, saving more, or adjusting their spending in retirement. Derek, you make the point that capital market assumptions are different than Monte Carlo. From a practitioner's perspective, how do you deal with this disconnect?

Tharp: As I mentioned earlier, this is where something like regime-based Monte Carlo could help set forward-looking capital market assumptions. If you can't do that, then just being conservative, as Bob just mentioned, will allow you to present different scenarios—one that's conservative, one that's more aggressive—giving us a spectrum rather than trying to be overly precise and relying on one projection. My broad-picture criticism of Monte Carlo is that it cannot provide insight on what a dynamic retirement-spending strategy would actually look like for a client. It's going to be so different from reality that clients can't use it to make decisions or to even pick a retirement-income strategy.

Davidow: Jim, you wrote a terrific paper about this that appeared in the

Retirement Management Journal (Sandidge 2020). And Derek, you're right. Too many advisors apply too much precision to Monte Carlo and don't explain the limitations.

Powell: Michael Finke of the American College is famous for saying that Monte Carlo is right once, the moment you produce the output, and never again.

Davidow: Great comment.

Sandidge: Great point, yes. Look, people are averse to uncertainty, and a lot of people will grasp at data and information in order to deal with uncertainty. And I think that's what you're talking about with Monte Carlo. Some people may lean on it too much, and my concerns with Monte Carlo are that the inputs are extremely flawed.

Say you and your neighbor retired in the year 2000, with \$1 million each, and say you put your money into the S&P 500 Total Return Index, and you earned 6.1 percent a year over the next 17 years. But say your neighbor takes all that money and splits it between Treasury bills and long Treasuries and earned 4.8 percent a year over that same time-frame. Now, if you're able to own your portfolio with no fee, you still ran out of money in the 17th year using a systematic approach. Your neighbor, however, had to pay a 1.5-percent annual fee but actually finished the 17th year with 40 percent of the principal intact. So the portfolio that had a lower return, 4.8 percent versus 6.1 percent, with lower volatility and a higher cost—a 1.5-percent fee per year versus no fee—generated a better outcome. This flies completely in the face of everything that the industry has taught new investors—that you have to take on more risk to earn a higher return, to generate more wealth long-term.

But it really illustrates the fact that when you're dealing with nonlinear processes such as retirement income, the inputs are not proportional to the output. That's

the very definition of a linear versus nonlinear process. Linear, they're proportional; nonlinear, they're not. So what it means is they're not predictive. Any kind of average return, whether it's meeting an index rate, meeting the inflation rate, anything like that, is not predictive of outcomes.

Now think of the next step. It's 1966 when you retire and apply the systematic approach. At the end of 25 years, \$1 million is worth \$94,000. Make one adjustment in the first year to the risk allocation—instead of using 50/50, you use 30/70—and that doubles your ending value to more than \$200,000. Make one more adjustment by skipping a cash-flow increase in the fourth year, and it pushes your ending value up to \$400,000. So two very small seemingly insignificant adjustments quadrupled your ending value. Over the remaining 21 years, the portfolio had three more negative years, and if you skipped increases those years you finished with \$660,000. If you employed a loan strategy where you had access to an outside source of funds such as a line of credit, and you took your distributions from that during negative-return years and paid it back the next positive year with 4-percent interest, that pushed your ending value up to \$750,000. That's a pretty big difference between \$94,000 and \$750,000. It really reflects the impact of the butterfly effect and the difference between systematic withdrawals versus actively managing a retirement income portfolio.¹

You see, the inputs that Monte Carlo uses—returns and fees—are not predictive of success. And yet the inputs it does not use—the adjustments the advisors will make—have a very significant impact on the outcomes. I'll give you one other example. From 1950 to 1974, a 50/50 portfolio averaged 7.2 percent, and you finished the 25th year with 103 percent of your investment intact. But if you earned the same returns in reverse order, you ran out of money in the 19th year. So if someone tells me

that their capital market assumption is 7.2 percent, which 7.2 percent do I get, the good one or the bad one? And that's only the start of it.

The calculation for how many ways you can arrange 25 items, in this case 25 returns, is 25 times 24 times 23 and so forth. If you do that, you come up with 15.5 septillion different ways to arrange 25 items. A septillion is one followed by 24 zeros. So if you give me one capital market assumption, 7.2 percent in this example, there are 15.5 septillion different paths and possible outcomes for the retiree to end up on. Now let's say you're using maybe a high, a low, and the most likely return assumptions. Each of those is going to generate another 15.5 septillion. And if you make any changes to the cash flow or the risk allocation, there's a completely different path and outcome. So again, the capital market assumptions, they're just not predictive. Plus, it's awfully hard to be very accurate consistently in predicting anything at all like financial markets.

Davidow: Monte Carlo is a valuable tool, but I'm hearing from all of you that there is an overreliance on this technique and advisors apply too much precision to the output. If not Monte Carlo, what should advisors be doing? Are there better tools and techniques?

Powell: What Jim's saying speaks to the papers that Derek wrote about how you could have a 50-percent probability of success as long as you were adjusting annually (Tharp 2021a, 2021b). And that gets to Jim's point: You make these adjustments and outcomes change. You can't rely on the one-moment-in-time result.

Some advisors I talk to triangulate around this. They'll use Monte Carlo, but they won't rely on it entirely. Some of the folks who, for instance, have the Retirement Management Advisor® designation will add in the fundedness calculation, and then still others will add in some of the work that Jim Otter, the

author of *Advanced Retirement Income Planning*, has done with respect to aftcasting.² So they're not relying on one tool, they're using multiple tools. Think about it like this: When you're looking at predicting a hurricane, people are using different models to determine where landfall likely will be. The same is true here. You can't rely on Monte Carlo alone. You'll need to triangulate using some other tools.

Monte Carlo is a valuable tool, but I'm hearing from all of you that there is an overreliance on this technique and advisors apply too much precision to the output. If not Monte Carlo, what should advisors be doing?

Davidow: I want to pick up on that hurricane model, Bob. We all accept that weather forecasting is imprecise. But I wonder, when an advisor presents a pie chart and a speedometer showing a high probability of success, whether investors view it with the same skepticism as they view a weather forecast. I suspect that many investors accept the results as a fact—a virtual certainty.

Derek, I'd love for you to weigh in. We don't want clients to wake up at the end of their 20-year plans and realize they are not ready for retirement.

Tharp: Monte Carlo has its place, but I don't know that probability of success needs to be a client-facing metric. It might inform an advisor's recommendation in the background. When you look at the various ways that advisors have communicated results to clients, there's a lot of value in a guardrails framework. In other words, give somebody some insight of what they can spend based on a certain model, with all the limitations included, but also tell them at what

point they could increase their spending and by how much, and at what point they would need to decrease their spending and by how much. Most of these approaches have previously been implemented with withdrawal rates driven by guardrails—frameworks such as Guyton-Klinger or Kitces’ ratcheting safe withdrawal rate, where adjustments are driven by the withdrawal rate.

But you can do something very similar with Monte Carlo by picking up that client-specific information. Maybe the client is retiring at age 62 and delaying taking Social Security until age 70, so pulling from the portfolio more heavily at the start of retirement. You can use that nuance rather than just targeting a certain withdrawal rate.

We still want to think about the capital market assumptions we’re using, we want to think about the limitations. But what we present to clients could be a recommended spending level, the different guardrails you can operate within, when changes would occur. All that could be powered by Monte Carlo analysis, by historical simulation, by withdrawal rates. You could triangulate, as Bob was saying, and get insight from all those different approaches. Then present it to the client so that maybe the probability of success isn’t even the focal point, because I think it is hard for clients to understand—it’s too easy to misinterpret and could easily lead somebody astray.

Davidow: Derek, that makes a lot of sense and it seems very practical for an advisor. Jim, I’m curious what you think about Derek’s approach. I like the guardrail approach, and I think we can agree about the value of communicating the limitations of Monte Carlo to clients.

Sandidge: Here is the one big concern I have with Monte Carlo. Most people can only hold three to five chunks of information in their working memory. If you exceed that amount, they get confused.

They don’t remember what you talked about. And unfortunately, working memory declines as we get older, partly because our ability to suppress irrelevant information also declines as we get older. So I think it’s extremely important, first of all, in terms of problem-solving, to focus on the essence of the problem. It’s also important from a communication perspective. You must become a master of excluding things. It’s easy to exclude superfluous information that’s not all that important. It gets much tougher when you have to start cutting out things that you feel are important. You really have to zero in on the very most important aspect of any problem. Einstein understood this. He was famous for looking for the most comprehensive but simplifying axioms of any problem.

Monte Carlo focuses on spending all your principal, but it misses the nuance that most people don’t want to spend any principal. You must be able to articulate how much you plan to spend this year and next year and the year after.

Aside from that, I also have a lot of criticisms of Monte Carlo in general, criticisms about its methodology and how it works. One of the costs of using it, I think, is having to talk about it. You need to do a cost benefit analysis. I really believe that an advisor needs to zero in on the essence of the problem, which is managing negative returns. Talk about your plan to manage the worst-case scenarios and then adapt to the environment that you’re in. That’s really the approach.

I think the tool for that strategy is to focus on the annualized erosion rate for

the portfolio. Monte Carlo focuses on spending all your principal, but it misses the nuance that most people don’t want to spend any principal. You must be able to articulate how much you plan to spend this year and next year and the year after. Your clients are going to know how much money they have the day they retire. One year later, they will look at how much money they have and compare it to what they started with. If it’s less, human nature will project that into the future. If they have 5 percent less than they retired with they’re going to say: “At that rate, my money runs out in 20 years. I’m not too comfortable with that.” That’s the calculation clients are already doing, so you should incorporate it into the discussion.

You talk about how we’re going to manage the worst case, this is your strategy, this is your risk allocation, this is how we’re going to adapt to the environment, this is our strategy around cash flow. Discussing Monte Carlo with clients and explaining Monte Carlo to them is where you’re in danger of creating a mental dazzle that distracts them from the essence of the problem.

Davidow: I feel like our members just received a master class on Monte Carlo. Bob, I wanted to turn it back to you just as we think about closing up this session. Is there anything that we haven’t covered, anything that you think would be particularly interesting?

Powell: I’ll mention a couple of things, and what Jim was saying has sparked my comments. When I take my car to a mechanic, he doesn’t need to explain to me which ratchet set he used or what he did to improve my car’s fuel efficiency. I just want the car to get better gas mileage. I think advisors use Monte Carlo in much the same way, but they feel compelled to explain it to the client, maybe because they feel like they are presenting certainty around an uncertain outcome.

This creates a whole other problem—behavioral bias around anchoring. If you tell me I've got a 90-percent chance of success, well, now I'm anchored on that number. I don't know what 90 percent means, by the way. I want to be 100-percent successful at retirement, but I come away with this outcome that's less than 100 percent. I hear that my expected rate of return is X, I'm anchored on that, but the standard deviation is such that I might be -20 percent or +30 percent. And those are the parameters that we're working within with one standard deviation.

Davidow: Those are terrific comments. I thank you all, we have covered a lot of ground. We may choose to revisit this topic in the future. There seems to be an overreliance on Monte Carlo and perhaps an expectation that there is greater precision than what exists.

Sandidge: Tony, can I add one final point to the discussion? You need to compare what a skilled advisor who truly understands retirement income comes up with to Monte Carlo projections. The Monte Carlo projections probably understate the possible outcomes. For someone who doesn't know fully the nuances of retirement income they might actually overstate, because the butterfly effect works in reverse. One wrong small adjustment could have a big negative impact. So it's extremely important for advisors to become as educated as possible on retirement income, how it truly is a different problem. Certainly the people who are reading the write-up of this roundtable are well on that road. They're taking the time to learn these things. I do think that, compared with what skilled advisors are capable of, a Monte Carlo approach would understate the outcomes.

Tharp: One of an advisor's real challenges is communicating expectations when picking a strategy. So whether you're using a guardrails strategy or a flooring strategy or whatever, what

should a client expect? The typical Monte Carlo is not capturing any of that dynamic planning. I'm biased here, I'm on the advisory board for Income Lab,³ but what we do there is help advisors analyze a strategy and set both the short-term and the long-term expectations by giving people a sense of the income they may actually experience with a given strategy.

That's missing from the current conversation. People don't realize that if you were to pick a strategy, like a constant 90-percent probability of success, and just adjust your spending accordingly, you will have an incredibly volatile spending pattern. The point of my 50-percent probability of success article was not to say that I think 50 percent is the number advisors should be using. It was to say that if you are regularly updating your probability of success, the difference between the spending levels planned at 50 percent versus 90 percent is nowhere near as large as most people intuitively think. Even myself, I wasn't expecting to see how similar those were.

How do you communicate what the natural income experience is like for a client? That communication is another piece of the puzzle. In many respects it's more important than giving somebody a 90-percent probability of success output that gives them a false sense of certainty. I would echo Bob's point that yes, this probability of success can be a tool, but it's probably a tool that needs to be behind the scenes unless you have a client who really wants to dig into the details.

Powell: It's important to note that the whole ecosystem, the regulatory environment around Monte Carlo, is supportive of Monte Carlo. Turning this cruise liner around to accommodate other tools may be a long-term process. Getting advisors to think about using other tools is going to be an interesting challenge.

Davidow: Thank you all for an engaging discussion. I know our members will benefit from your insights. ●

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ENDNOTES

1. The butterfly effect gets its name from the idea that a butterfly flapping its wings in Brazil could trigger a sequence of events that culminate in the formation of a tornado in Texas. In other words, small differences early in a nonlinear process potentially can result in big differences later.
2. Aftcasting uses the actual market history, including growth rate and inflation, as they exactly happened in history. It reflects actual sequence of events, actual sequence of returns (stocks, interest rates, and inflation), and actual correlation between stocks, interest rates and inflation, actual volatility, and actual black swan events exactly as they occurred since 1900. It allows investors to see the worst-case situations and what can go wrong, instead of assuming average growth rates or inflation. Unlike simulators, aftcasting shows the impact of random as well as fractal events of the past. Source: <http://retirementoptimizer.com/>.
3. Income Lab is a provider of dynamic retirement-planning software that incorporates economic and market conditions, dynamic spending analysis, tax-smart distribution planning, and automated plan monitoring and management.

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