



Value at Risk & Return Variability

by Glenn E. Atkins, CFA

How do you incorporate risk and volatility into an investment planning decision? It is widely known that large-company stocks have returned, on average, about 10% per year. However, if you assume you get a flat 10% every year, year in and year out, you have completely removed the timing effects of volatility from consideration. You might average 10% over time (as the markets have historically), but it will occur with the natural ups and downs of the market.

Another widely known point is that the average annual volatility (standard deviation) for stocks since 1920 has been about 15.58. We'll call it 15. So then, how do you factor volatility and uncertainty into your uncertain investment horizon?

There is a technique called Monte Carlo analysis that is designed to take just this variability into account. I almost wish they hadn't named it that because it invokes visions of gambling which, of course, it's not. It's really just an elegant way to think about risk and to factor market uncertainty and unpredictability into your planning horizon. It accounts for the variability of return – the fact that returns don't occur smoothly over time. Ten percent year after year is not going to happen. You might average 10% over time (as the markets have historically), but it will occur with the natural ups and downs of the market.

Monte Carlo analysis got its start during the second-world war when a Polish mathematician named Stanislaw Ulam and his buddy John von Neumann were working on the randomness of nuclear fission at Los Alamos. The thought actually occurred to Ulam when he was home, sick, playing Solitaire. Monte Carlo is named after the city in Monaco largely because of this city's affinity for roulette, which is a simple random number generator. For you purists out there, Monte Carlo is known as stochastic modeling.

“...more real than putting your head in the sand...”

Recall from your statistics classes that many events in the world can be described by a normal distribution – that famous bell curve, where 68%, 95%, and 99.72% of observed events occur within one, two, and three standard deviations, respectively. If this is true for stocks then we might expect about 68% of all future stock returns to fall in a range of plus or minus one standard deviation

from the average return of 10%. So in the case of our example we would expect 68% of future returns to be between 10% - 15% or -5% and 10% + 15% or +25%. Further we would expect about 95% of returns to be in the range of 10% -30% (2 standard deviations) or -20% and 10% + 30% or +40%. Almost 100% (actually 99.72%) of returns can be expected to fall within 3 standard deviations or -35% to 55% annually. I can hear you statistics people thinking, “but aren't stock returns log-normally distributed?” They might be, but they also might be exponentially distributed. This is hard enough as it is, so we are just going to assume they are normally distributed.

So how do we account for future uncertainty?

We generate a series of random numbers (representing possible market returns) that are distributed according to the bell curve and that are within the confines of the historical average return of 10% and the historical average standard deviation (volatility) of 15% according to the following formula:

$$1 + ((HR + RN) * SD)$$

where HR = historical return of 10% as a decimal

RN = a normally distributed (bell curve) random number, which can be negative

SD = historical standard deviation (volatility) of 15% as a decimal

If we do this 10 times over each of the next 10 years we might get a table that looks like the one in this article.

The top half is our random returns according to the formula above. Assuming we begin with a portfolio of \$500,000 and withdraw \$60,000 at the beginning of each year, the bottom half is our ending portfolio value for each iteration in each year. For example, for iteration one in year one we get \$500,000 - \$60,000 = \$440,000 x 1.1551 = \$508,244 (cell A23) and so forth for each iteration in each year.

What does this tell us? It tells us the probability that we will be successful given our assumptions regarding return, volatility and our annual withdrawals and some other things like inflation that are not included here in order to keep it as simple as possible. Look at column J, the one for year ten. Three of the possible random journeys that our portfolio might take are not successful. We run out of money. Conversely, seven of them are successful so we say that we have a 70% chance or probability of meeting our goals (in this case of not running out of money, but the goal could be any value). Also, we can be reasonably sure that we will be 100% successful out to year five, because all ending portfolios are positive. If we assumed

Continued on page 3



Special Announcement

by James B. Bell, CFA

It is James' normal rotation to write this quarter but we let him have some time off to celebrate the birth of his and Shelli's first baby. Owen Gerald Bell was born October 9, 2003 at 5:27 p.m.

He was 7 pounds 14 ounces and 20 inches long. The family is at home and healthy. Your friends at Garner Asset Management share in your joy.

Value at Risk & Return Variability *Continued from page 2*

	A	B	C	D	E	F	G	H	I	J
9	Random Returns									
10	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
11	1.1551	1.3064	0.9991	0.9354	0.9732	1.3271	1.0408	0.9758	1.1684	1.2071
12	0.9679	0.9725	1.2358	1.2777	1.2452	1.1291	1.0026	0.9879	0.8195	1.0419
13	1.3361	0.9300	1.2359	1.1789	0.9938	0.9113	0.7758	0.9753	1.0483	1.0715
14	1.1764	0.8860	1.2852	0.9771	1.1131	1.0573	1.0917	0.9400	1.0608	1.0789
15	0.9452	0.7160	0.8852	0.9355	1.1674	1.2219	1.0433	0.9053	1.0198	1.1710
16	1.2804	1.0922	1.2168	1.0217	1.1946	0.8883	1.1005	0.9395	0.8687	1.0402
17	1.3254	1.3174	0.9721	0.9465	1.1580	0.9695	1.1070	0.9725	1.4291	1.2435
18	0.9748	1.0790	1.2362	0.7078	1.0984	1.0821	1.0040	1.3192	0.9643	1.0013
19	1.2903	1.0262	1.0850	1.0283	1.0181	1.1231	1.3110	1.1394	1.2180	0.9905
20	1.1781	1.0360	0.8558	0.7385	0.9662	1.0887	1.2388	0.9731	1.2203	1.0886
21										
22	Ending Portfolio Values									
23	508,224.06	585,577.33	525,111.47	435,058.53	365,002.48	404,773.94	358,839.39	291,603.51	270,612.98	254,225.77
24	425,887.08	355,830.88	365,579.98	390,452.57	411,493.32	396,864.06	337,750.72	274,390.32	175,697.37	120,545.18
25	587,865.17	490,913.14	532,579.89	557,116.06	494,037.07	395,559.64	260,338.18	195,396.90	141,941.32	87,803.26
26	517,631.94	405,477.55	444,009.57	375,203.16	350,861.35	307,519.22	270,216.54	197,610.11	145,975.83	92,757.64
27	415,890.63	254,811.53	172,442.50	105,184.83	52,748.27	(8,861.21)	(71,845.72)	(119,358.83)	(182,911.42)	(284,445.89)
28	563,383.05	549,808.15	595,979.84	547,622.28	582,518.82	464,168.08	444,766.99	361,478.12	261,896.97	210,009.69
29	583,160.05	689,235.20	611,665.18	522,169.97	535,190.26	460,717.93	443,581.14	373,047.35	447,391.14	481,715.54
30	428,930.52	398,074.85	417,934.64	253,350.47	212,383.65	164,891.60	105,309.67	59,771.81	(220.04)	(60,297.57)
31	567,712.41	521,002.42	500,178.11	452,619.82	399,720.87	381,551.79	421,569.68	411,960.42	428,689.08	365,186.61
32	518,359.23	474,843.42	355,009.64	217,873.90	152,543.10	100,751.86	50,482.23	(9,262.08)	(84,520.56)	(157,321.54)

a constant, level return of 10% annually we would say that we are assuming we would be 100% successful all the time, which is probably an unrealistic assumption given the way markets behave. In fact, you would be wrong almost all the time because what are the chances that the market will return exactly 10%?

The real beauty of this would be to conduct this analysis for say 5,000 to 10,000 iterations instead of just 10 (as above) over the next 30 years or whatever your planning horizon is. The computational limits of current spreadsheet technology are probably in the neighborhood of 30,000 iterations over 50 years. It takes my computer (with several other programs open) about 9 minutes and 2 seconds to do these 1,500,000 calculations (it's actually a lot more than that) and give me the output and draw a bunch of graphs and stuff. Wow! This seems awfully slow given that we expect our spreadsheets to be almost instant, but

when I think of the math involved it almost blows my mind that it doesn't take a week and a half! From a practical standpoint, 5,000 to 10,000 iterations are probably enough.

Monte Carlo has a lot of limitations but it is a great tool for modeling future unknowns, especially known future withdrawals mixed with unknown and unpredictable market downturns. Some people may not like the idea of being less than 100% certain in some cases, but it's more real than putting your head in the sand and assuming no future volatility and level, year in and year out, market returns. You can ignore uncertainty if you want, but your portfolio has to live it – and survive it. In the end, it might actually give you greater comfort by allowing behavioral tendencies (i.e., spending and saving patterns) or asset allocation changes to occur now when they might be more easily managed, versus 30 years from now when it's too late. Feel free to call or e-mail me for more information. ■

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