Retirement Projections and Monte Carlo Analysis

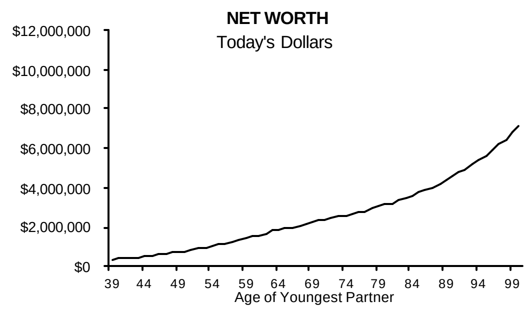
Risk is uncertainty. Life is full of risk. Even a stroll in the park can expose one to falling pigeon droppings. Most risk increases with time. One is far more likely to be involved in an auto accident over the next 30 years than next week. Retirement is no different. In fact, the longer we expect to live, the more risk we are exposed to.

The list of risks faced in retirement is long; too little or too much free time, boredom, grandchildren too distant to visit regularly, a rotten golf swing, physical ailments, etc…

The good news about senior citizenship is that we are living longer. The bad news is that we have to pay for it. Risks revolving around financial resources include investment returns, lifestyle and spending habits, inflation, changing government programs, pension benefits, medical expenses, etc…

Most retirement projections make fixed assumptions about chief variables. A typical retirement projection specifies a rate of return on investments, probably based on historical data, and uses that same rate for each and every year of the projection.

Static Projection Graph



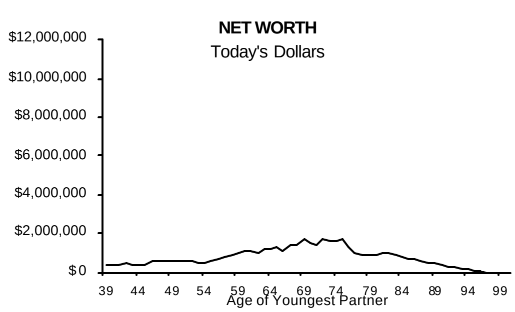
Yet we know with absolute certainty that that investment markets will not return the same earnings each year, but will vary significantly. These variances could mean the difference between prosperity and outliving your resources.

Monte Carlo simulation is a statistical technique developed for the World War II Manhattan Project to estimate the impact of atomic explosions without actually setting off the devices. We use it to model the impact of changing investment returns and inflation on your retirement.

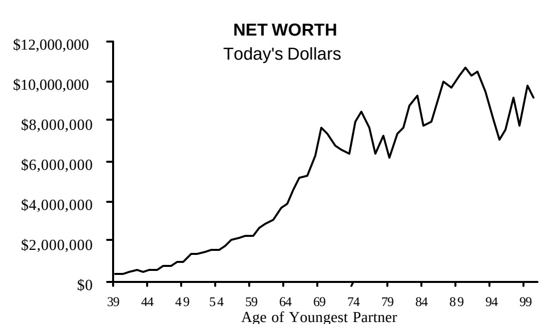
Monte Carlo starts with a projection similar to that which was used for the static graph above. Each time, however, we change the investment returns and inflation rates for each year – as will happen in real life – within the historical bounds of past performance. For example, instead of forecasting a 9.5% return in 2000, 9.5% in 2001, 9.5% in 2002, and each year of the simulation, the simulation might project 14% in 2000, -5% in 2001, 2% in 2002 – a more lifelike, and more complicated approach.

Sample Monte Carlo Results

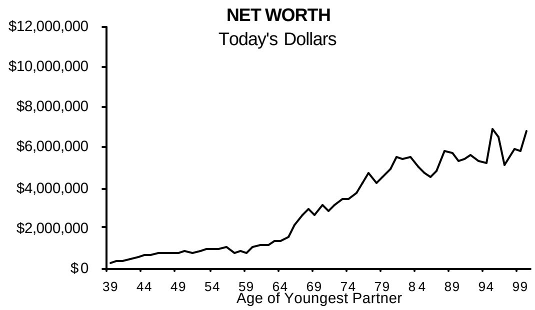
OUCH!…



…YIPPIE!…



…OR, A SIMILAR OUTCOME TO THE STATIC PROJECTION ABOVE.



Each simulation uses the same average investment return and inflation rate as the static projection above, the timing of the good years and bad years is all that changes.

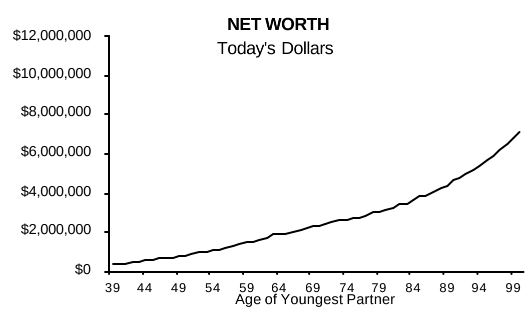
Bottom Line: Monte Carlo estimates the likelihood that a given retirement strategy will succeed. Wouldn't you like to have an estimate of the odds that a particular retirement strategy has to meeting your life objectives?

What probability of remaining financially self-sufficient through retirement makes you comfortable: 60%, 90%?

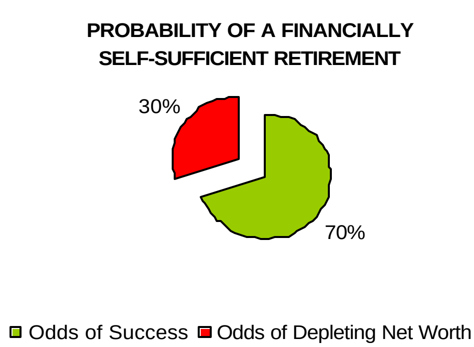
LEAVE IT TO BEAVER

The retirement projections above belong to June and Ward Cleaver. They are middle class, middle aged, diligently saving for retirement at age 67. They have a moderate risk tolerance and expect historical investment returns and inflation rates to prevail. They've accumulated some wealth so far, and they plan on living to age 100, a conservative assumption given increasing life-expectancies.

The static projection shows that they will have a net worth at the end of retirement of $7,000,000. This looks great – especially to their kids, Beaver and Wally!



Monte Carlo analysis points out that this scenario is not without risk, however. The probability that Ward and June will outlive their money – and have nothing to leave to Beaver (or Wally) is 30%.



How To Interpret Monte Carlo Results

As already indicated, Monte Carlo takes into consideration the yearly variance in the rates of return. To do this, we must create a year-by-year look at the cash flow. Each year's return has a "Monte Carlo Randomizer" attached to it. This process is computed in a spreadsheet, and each spreadsheet must be customized for every individual. Once the spreadsheet is completed, and all of the rates of return have a Monte Carlo randomizer attached to it, then a result can be computed.

In most situations, the result we analyze is the future value of the portfolio, usually when the investor's age reaches 100. The Monte Carlo simulation looks at the growth of the portfolio each year, building upon the previous year, taking all the assumptions into consideration, and randomly changing the rate of return. Below is a simplified example of a single "trial:"

		Income		Expense	Portfolio Adjustments		
Year	Age	SSI	Pension	Living Expense	Surplus/ Shortfall	Monte Carlo Randomized Return	Portfolio Value
2000	63	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	4.40%	$674,212.68
2001	64	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	15.46%	$721,841.94
2002	65	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	31.09%	$889,692.35
2003	66	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	-2.43%	$811,454.10
2004	67	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	-2.14%	$737,482.09
2005	68	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	10.83%	$760,723.52
2006	69	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	30.72%	$937,832.40
2007	70	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	10.86%	$983,064.40
2008	71	$ 14,400	$ 24,000	$ 95,000	$ (56,600)	17.28%	**$1,096,294.89**

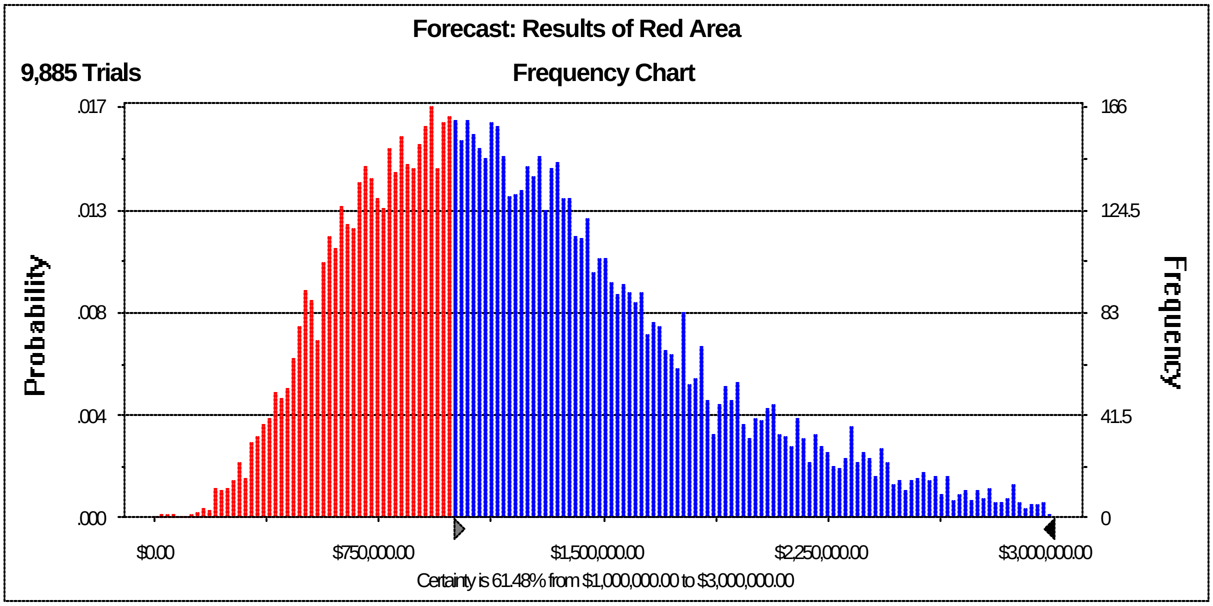
The area in green represents the rates of return that are randomized by the Monte Carlo. The area in red represents the value of the portfolio at age 71. This diagram represents a single "trial." To complete the analysis, we will use a powerful computer to run the same process up to 10,000 times – each of these equating to one trial. Below are three additional trials. Notice that the rates of return are different in each example, as is the end result, shown in red.

Portfolio Adjustments		
Surplus/ Shortfall	Monte Carlo Randomized Return	Portfolio Value
$ (56,600)	18.50%	$772,896.12
$ (56,600)	-1.86%	$701,927.74
$ (56,600)	17.99%	$771,617.49
$ (56,600)	31.76%	$960,106.26
$ (56,600)	-7.74%	$829,229.57
$ (56,600)	-0.37%	$769,592.46
$ (56,600)	-2.29%	$695,367.30
$ (56,600)	24.47%	$808,901.76
$ (56,600)	8.48%	**$820,866.17**

Portfolio Adjustments		
Surplus/ Shortfall	Monte Carlo Randomized Return	Portfolio Value
$ (56,600)	17.59%	$766,533.16
$ (56,600)	3.41%	$736,048.43
$ (56,600)	27.51%	$881,926.67
$ (56,600)	21.81%	$1,017,660.91
$ (56,600)	28.39%	$1,249,970.72
$ (56,600)	20.72%	$1,452,393.45
$ (56,600)	18.15%	$1,659,404.78
$ (56,600)	32.84%	$2,147,723.74
$ (56,600)	31.82%	**$2,774,466.90**

Portfolio Adjustments		
Surplus/ Shortfall	Monte Carlo Randomized Return	Portfolio Value
$ (56,600)	10.37%	$715,977.01
$ (56,600)	-11.54%	$576,758.13
$ (56,600)	12.40%	$591,655.97
$ (56,600)	12.58%	$609,485.95
$ (56,600)	17.10%	$657,133.11
$ (56,600)	13.92%	$691,978.24
$ (56,600)	22.86%	$793,578.47
$ (56,600)	18.94%	$887,298.62
$ (56,600)	-8.37%	**$756,408.42**

What should become apparent by the values highlighted in the red box, is that over a period as short as nine years, there are substantially different results – from a low of $758,408 to a high of $2,774,466. Once all the "trials" have been complete, the result is graphed. The graph on the next page shows the different values of the portfolio at age 71, after 9,885 trials.



This graph shows the value of the portfolio at the investors age 71 after 9,885 "trials." As you can see, it is a skewed bell shaped curve. The vertical bars in the graph represent the frequency of a portfolio value. The Red represents frequencies below $1 million and the Blue represent frequencies above $1 million. There is a 61.48% probability that the portfolio will be above $1 million at age 71.

When conducting a retirement needs analysis, the main risk we are addressing is not to outlive one's money. This is why we pick an age in the future, generally 100, and run the Monte Carlo to determine the probability that the portfolio will be above $0 at the investors' age 100. However, any set of variables can be used and any scenario addressed.

LIMITATIONS UNIQUE WITH MONTE CARLO

As with any type of forecast, there are limitations. One of the major limitations with all financial planning analysis is that we are making assumptions about the future. Currently, Monte Carlo is the best tool to address this main limitation. However, there are some limitations that are unique to Monte Carlo as it relates to financial planning.

The most obvious limitation is in the random generation of annual returns. Each year, the return is generated randomly, based on the statistical returns of the investment, with no consideration given to the previous year's return. However, securities markets do not operate independently year by year. This fact causes the Monte Carlo to yield inaccuracies.

As an example, think of the dice game craps, which is played with two six-sided dice. There are eleven possible outcomes, 2 through 12, with the number 7 being the most common and 2 and 12 being the least common. If one were to roll the dice twenty times and the number 2 was rolled every time, the likelihood of rolling another 2 is the same as the very first roll of the dice. Taking the S&P 500 as an example, if it has three years in a row with a negative return, the likelihood of the next year's return being negative is less than the likelihood of a negative return three years ago. However, Monte Carlo works like the dice example, where every year is independent of the previous. It is unable to take this "reversion to the mean" associated with investment returns into consideration. For this reason, the far ends of the results – the best and worst values – are not likely.

It may seem like this limitation causes the results to be meaningless, but this not the case. If the result is a 90% probability of reaching the end goal, then one can be fairly certain that even if the stock market went through another period like it did in the Great Depression, it will not adversely affect the end goal. On the flip side, if there is only a 10% probability of reaching the end goal, one should change assumptions or plan on running out of money.

While Monte Carlo is not perfect, it is currently one of the most sophisticated tools for financial forecasting.