Monte Carlo Retirement Simulators Usable by Everyone (Preliminary Version)
Floyd Vest, Sept. 2015

For an example, go to the internet and Search: monte carlo simulation in finance. Go down to Vanguard – Retirement nest egg calculator which addresses the question, How long will retirement funds last? Use Vanguard’s inputs: Probability that funds will last 30 years. First year withdrawal $45,000. Original balance in the retirement fund $1,000,000. Portfolio: 20% stocks, 50% bonds, and 30% cash. Returns and inflation for each year are selected at random from a data base. The data base covers years from 1926 to 2013. Click Run simulation. You will read that based on historical data, there is a 74% chance that the portfolio of $1M will last 30 years. Notice that this could be interpreted as predicting the future based on historical data. There are reasons not to trust this interpretation. Out of 5000 runs, 74% lasted 30 years or more, and 26% failed to last 30 years. In the model, annual withdrawals are increased at the rate of inflation selected at random from the data base. See the Exercises for a discussion of whether the data for a particular historical calendar year was coupled, or this was programmed as not expected. You will notice that some of the runs left over $3,000,000 on the table after 30 years, and some exhausted funds at about 19 years.

Exercise #1. If the funds lasted 19 years, what constant average real rate of return is represented by this result. Answer y = 2.057%. Show your calculations.

Exercise #2. Run a scenario with 100% stocks. Give the probability of funds lasting 30 years, not lasting 30 years. What is the least number of years funds lasted? Discuss what could cause this. In the history of consecutive calendar years, do you think this ever happened? You will notice that having over $3M left on the table happened quite often. If you think $45,000 is not enough, do some what-ifs with a 60/40 portfolio. Report. What about these being funds being used to supplement Social Security? What opportunities do you miss if you invest in an inflation adjusted immediate annuity? Some experts recommend a reverse mortgage early in retirement. Some recommend diversification into real estate, international stocks, and commodities, and so on.

Exercise #3. We could play with calculations involving constant averages which almost never happens historically. Assume the return on stocks is r = 10%, inflation I = 3%, start withdrawals at $45,000 increasing yearly at 3%, original balance of $1M, how much is left after 30 years? The answer is $7,502,599.70. In a sense this could be the average left on the table under the Vanguard simulator with 100% in stocks.

The withdrawal strategy used here could be called the 4.5% rule. See the References. This calculation suggests that it is not unreasonable for a large percentage of the runs to end with millions of dollars left in retirement account.

Exercise #4. If runs ended with more than $7,502,599.70, what could cause such an event?
Exercise #5. On the Vanguard page, click on What is Monte Carlo Simulation? In the first example, they give an average annual rate of return of about 12%. Gather their input data and mark the graph with years and millions of dollars. You will notice that the balance after 30 years was about $6,400,000. They didn’t report an average inflation rate I. Calculate or estimate I. Give the real rate of return. Give a formula for the balance for years 1, 2, ..., 30 and graph the balance in the fund. We estimated I = 3% and a final balance of $6,327,723 after 30 years. How does this compare to Vanguard’s graph?

Exercise #6. The second example gives a different graph of portfolio balance during retirement. Gather the input and mark the graph in years and millions of dollars. What happened in the first two years? Assuming 3% constant average inflation, estimate the balance at the end of year 1, at the end of year 2.

Exercise #7. The third example presents yet a different graph of balance in the fund. Gather the input data and mark the graph in years and millions of dollars. What is the approximate final balance? In both cases, what was the average rate of return? Using I = 3%, what was the portfolio balance after year 1 and after year 2?

Exercise #8. They report an 80% survival. What proportions of stocks, bonds, and cash did they use to get 80%? Give some portfolios of stocks, bonds, and cash = 0% which have a better survival rates. Examine 90/10; 80/20; 70/30; 60/40; 50/50. Which portfolio would you prefer and why? Did different sets of 5000 runs on the same scenario give different results?

Exercises: Show your work. Label answers, variables, and numbers. Write in complete sentences when appropriate. Draw graphs roughly or print graphs. Label axes and units.

#9. Summarize the indexes used to represent stocks in the portfolio. Why did they use different indexes? Do you think the history went back to a period which will not be repeated?

#10. Summarize the indexes used to represent bonds in the portfolio. Discuss.

#11. What was used for annual returns on cash? What would you suggest for the layout of the data base and its data to be used with a random number generator for a Monte Carlo simulation?

#12. Do you think the simulation included total return, and compounded returns?

#13. Using random number generators, how would you run a simulation which couples calendar year data? How would you design where coupling is not expected?

#14. What assumptions are made in Monte Carlo retirement simulations?

#15. Read two articles on the internet: “Odds-On Imperfection: Monte Carlo Simulation”, and “Using Monte Carlo Simulations in Financial Planning Software.” Use them to critique the Vanguard retirement simulator. Is it not subject to some of the criticisms? List and discuss. Is it subject to some of the criticisms? Discuss. List 20 factors that affect preretirement planning and 20 factors that affect planning for and near the retirement years. Which makes the most
sense, Monte Carlo simulations for preretirement, or Monte Carlo simulations for the retirement years?

#16. Discuss “potential market scenarios – up and down markets, of various lengths, intensities, and combinations. Discuss “30 years” in terms of retirement age, longevity possibilities, living expenses for different age periods, the figure $45,000, and the figure $1M, etc. If a person has $1M in stocks, bonds, and cash, what is likely to be the value of their total retirement assets including Social Security? A better way to ask this question is, how much is required to supplement Social Security? The $1M scenario is for 2015 dollars.

#17. Assuming 3% inflation and -14.65% return for the first year and -26.47% for the second year, estimate the balance at the end of years 1 and 2. What happens to a person who runs a Monte Carlo simulation just before retirement, and retires just before these losses? In what successive calendar years did these losses occur?

#18. Assuming 3% inflation and 57.6% return for the first year and 31.6% for the second year, estimate the balance at the end of years 1 and 2. In what consecutive calendar years did the gains occur?

#19. Write the main points of “What is Monte Carlo Simulation?”

#20. Write a comparison of the penalty for outliving your money with that of dying with money. Give your recommendation.

#21. Scott Burns reports John and Jane with $1M, $40,000 first withdrawal, 30 years, age 65, 50% stocks, 50% bonds, a 95% chance that funds will last 30 years. Check his figures against a Monte Carlo simulation. (Denton Record Chronicle, Sept. 6, 2015)

#22. In Scott’s article, John and Jane want to withdraw $60,000. Their financial planner dutifully puts this into his Monte Carlo analyzer. He says, “Sorry that’s suicidal.” Check these results. Would you be impressed by a financial planner who had a Monte Carlo simulator?

#23. Scott says withdrawing $68,750 every year for 30 years has a 95% chance of not running out of money. Estimate a nominal rate of return for Scott’s 50/50 portfolio. Scott say John and Jane may leave $2,250,000 behind. What constant nominal rate of return does this use? You may need to estimate, or use a general solver, or graph.

#24. Scott says at 2% inflation, the $68,752 reaches a purchasing power of $40,000 at age 92. Check his figures. At 3% inflation it is down to $40,000 at what age? John and Jane think they will need less when they are older. What well-known retirement strategy starts with $1M and $40,000 first withdrawal?

#25. Retirement calculators at other sites. Popular sites are T. Rowe Price and Fidelity. They will require registration. One that doesn’t require registration is Retirement Calculator - CNN Money. Go to this site and note the type of required input, the type of output, and the explanations in fine print. The CNN calculator assumes for the first year, to pay out (85% of current income) less (Social Security). They assume the withdrawals starting at 85% of current
income increases yearly at 2.3% inflation. They get their Social Security figures from ssa.gov. Put in age 66, retire at 67. Note that the individual lives to age 92 and retires at age 67. This retirement income is financed by purchasing an inflation adjusted immediate annuity using a discount rate of 6%. It may be that the annuity pays to age 92. From the beginning of age 67 to the beginning if age 92 is 25 years.

We could conduct an exercise using the gross income of $45,000 from Vanguard. We calculate that in CNN current preretirement income is $52,941 since $52,941 = $45,000. But CNN allows $50,000 and $55,000 as preretirement income. Put in $55,000 as preretirement income in the CNN calculator. Put in amount saved is $0 so we can interpret the “You will need.” Put in savings rate of 1%. You will read that $410,226 is needed to finance the retirement.

To estimate Social Security, go to ssa.gov and Search: Quick Calculator. Put in birth date 6/15/1948. This gives age 67 in 2015. Retirement date 11/2015. Enter preretirement income of $45,000. You may read the Social Security benefit is $1443 per month or 12(1443) = $17,299 per year.

Go back to the Vanguard retirement calculator and put in 25 years, $410,000 as portfolio balance, and $45,000 – 17,292 which is approximately $28,000 as the first year payout increasing yearly at the historical rates of inflation. Put in 50% stocks, 50% bonds, and 0% cash. Run the simulator. Do you get 51% chance of success?

Discuss the comparison of the two calculators. Calculate an estimate of the price of the annuity. Calculate the price with 3% inflation. Try this figure on the Vanguard simulator. Check the internet for prices of immediate inflation adjusted annuities. Calculate the cost of such an inflation adjusted immediate annuity which lasts forever. Check the average rate of inflation from 1927 to 2013. Compare the different assumptions, inputs, calculations, and conclusions. How safe is the CNN calculator annuity? How can the insurance company sell the annuity at such a low price? Is it clear whether the annuity is for 25 years or 26 years or for life?

#27. Go to Retire Income Score Card: immediate annuities – CBS. Figure the cost of an immediate lifetime inflation adjusted annuity, which pays starting at $28,000 per year, for a single male, a single woman, and a couple. Compare this to the CNN calculator. Read other referenced articles by the author of this site. Discuss.

#28. Conduct interviews to see what major expenses, other than the usual cost of living, people have incurred. For example, one retired person had expenses: his daughter’s cancer cost $350,000, and another had a special school for his grandson $500,000. Would you pay for a grandson’s college education. Twelve percent of students work their way through college. How many millions of dollars would pay for major expenses during the retirement years?

#29. An economics lesson for long term planning: devaluing currency, real rate of return, long term bonds, China’s devaluation of currency, public private debt at 350 percent of GDP, the 250

#30 See the article “The Monte Carlo Method and Random Number Generators,” Consortium 56, 1995, COMAP. Com. in the section of this course entitled Additional Articles on Financial Mathematics or Related to Personal Finance. See the several references cited on the first page this referenced article. Do all of the Exercises. Report.

#31. On Dec. 18, 2011, Scott Burns reported that TIPS (Treasury Inflation Protected Securities) have been a good investment for many years, including a year-to-date return of more than 10 percent. That good performance also means that they are richly priced in Dec. 2011. Recently, for instance, Bloomberg listed a TIP maturing in five years with a current coupon of 0.125 percent selling at a premium. This means it provides a negative real return, even when you principal is adjusted upward for inflation. With a real rate of return of negative 0.8 percent, it would be losing that amount to inflation. Do the math to check Scott’s calculations. Look up the inflation rate for 2011. See the article in this course “Comparing After Tax Returns on TIPs and I-Bonds. (Taken from “If you have assets, you can manage your tax rate,” Denton Record Chronicle, Dec. 18, 2011)

Side Bar Notes:

Some Monte Carlo Simulations: Allen Roth says “I’ve seen simulations run using a base average return of 10% annually then adding a couple of percent to reflect the planner’s stock picking ability. Other models have a default of volatility that could only exist in a world where the stock market would only lose no more than six percent in every one of forty years. What did Allen say about using stock returns that go back to 1927? What did he say about Monte Carlo simulation for the time before retirement? (Money Watch)

More about women. If you visit the Twitter hashtag “I look like an engineer”, you’ll see thousands of photos of young women, all engineers, all cheerfully working to overcome the stereotype that only men are engineers. Today 47 percent of all medical students and 46 percent of all medical residents are women. (Scott Burns, “Granddaughter, car represents life’s changes,” Denton Record Chronicle, Aug. 23, 2015.) “Women have outnumber men in gaining college degrees for more than a decade.” (Scott Burns, Denton Record Chronicle, June 26, 2011)

The VIX index – known as the fear gauge measures the volatility investors expect in the stock market is well below its historical average of 20. Today’s calm investors may be in for a shock. Money, Sept. 2015, pager 82. What has been the record of the stock market since Sept. 2015? Report.

Immediate annuities. For a female, who pays $100,000: starting at age 60, an immediate annuity pays $480(12) = $5780 per year. An immediate annuity, starting at age 75 pays $710(12) = $8520 per year. An immediate annuity bought at age 60 and deferred to age 75

Testing 401(k) participants on knowledge of financial mathematics. The survey asked five questions covering compounded returns, the impact of inflation on purchasing power, diversification, tax savings of pretax contributions, and employer matching contributions. The least knowledgeable had an average equity allocation of 44.3% whereas the more knowledgeable had 62.3%. The more knowledgeable, the more likely to diversify. They were less likely to encounter volatility. They have more retirement savings. (AAII Journal, August 2015, p. 5)

Some studies of teaching personal finance in high school show no success.

Economic changes have little long-term impact on stocks. Bond prices are strongly correlated with economic changes. The economic factors studied were M2 money supply, ISM index of manufacturers’ prices, outstanding consumer credit, housing permits, initial jobless claims, and average manufactures’ workweek. Look up some of these terms on Wikipedia.org. Report. (AAII Journal, August 2015, p. 5)

Increasing the survivability of your retirement funds. John Ameriks and others found a decade ago that converting a portion of your retirement assets into a life annuity could increase the probability of portfolio survival. Another study has found that acquiring a reverse mortgage early in retirement has the same affect. They found that net worth at the end of 30 years (remaining home equity and remaining retirement assets) was greater as often as three fourths of the time. Do you think Monte Carlo simulation was used in the study? (Scott Burns, “Reverse mortgages: Their time has come,” Denton Record Chronicle, April 15, 2012)

Postponing Social Security can make your retirement income more tax efficient. Once you start Social Security, certain income can trigger the taxation of Social Security. Thus that income is double taxed. (Scott Burns, “If you have assets, you can manage your tax rate,” Denton Record Chronicle, Dec. 18, 2011) See the articles in this course “Income Tax on Social Security,” and “Delayed Social Security Retirement and Increased Benefits.”

Required Minimum Distributions (RMDs) begin on Traditional IRAs and 401(k)s at age 70.5. Scott Burns, Aug. 18, 2013 reported that a 50/50 portfolio earned 1.77% At that time. For a person age 70, the RMD was 3.65% of balance. All of the withdrawal is taxed at their marginal income tax rate. After the withdrawal, the portfolio had shrunk by 1.88%. For someone age 75, the RMD was 4.37% and funds would shrink by 2.6%. For age 80, funds shrank by 3.58%. If this continues, the retiree might not have enough funds to live on. They would prefer to use other funds than the tax delayed qualified funds. In 2013, Scott reported that in every year since 1998, a 50/50 portfolio shrank due to low returns and RMDs. This has not always been the case. In 1985, the 50/50 portfolio earned 7.19%, so portfolios for these ages didn’t shrink. For more information on RMDs, see the article in this course, “The RMD Strategy for Retirement Income Withdrawals” and IRS publication 590. (“Why RMDs are a principal concern,” Denton Record Chronicle, Aug 18, 2013) Explain how Scott calculates his RMD percentages. What about the yearly accumulated affect? RMDs can change your tax bracket. You may be able to do a Roth conversion until you reach the age for RMDs.
Most Americans own more home than they can afford. Owning a home free and clear at retirement is a goal for most people. Most do not achieve this. Today, most people approaching retirement find themselves owning more home than they will be able to afford when they retire. The metric for this is simple. If you have financial assets greater than the value of your mortgage-free house, you have a shot at a reasonable retirement security. Your house is a consuming asset. You need to pay real estate taxes, insurance, and repairs, not to mention other expenses. One recent survey found that only 20% of retirees had total financial assets other than the home which was greater than the equity in their home. (Scott Burns, “Do you own the right amount of home?” Denton Record Chronicle, April 20, 2014, page 2D)

True or False? For e-textbooks, it is less expensive to print out the electronic version than to purchase the heftier hardcover from the bookstore. (E-textbooks smart way to study,” Denton Record Chronicle, Aug. 8, 2015) What is your experience?

More jobs are requiring empathy skills. Empathy tests can be given to employees and others. Examples of empathy test questions are: How often have you helped a co-worker whom you did not know especially well with an assignment when your knowledge was greater than his? Another example is, I have tender, concerned feelings for people less fortunate than me. Possible answers: Never, Seldom, Sometimes, Often, Always. Empathy scores among college students is down 10%. (Fortune)

Investing in stocks. Twenty percent think stocks are the best long-term investment. Thirty-seven percent believe they can meet their financial goals without stocks. Fifty-two percent own stocks, down from 65% in 2007. (Money, Jan./Feb. 2014 p. 166)

Umbrella insurance adds liability insurance to your homeowners and auto insurance. Liability risks are everywhere. The average jury award for vehicular accident is $306,000. That’s why experts advise to buy umbrella insurance. A one million dollar policy can be bought for about $250. They advise having insurance of two time your exposed net worth. Your exposed net worth varies by state. Your wages and assets may at risk (though in some states, retirement funds, pensions, and your home are excluded). (Money, Jan./Feb., 2014, p. 40)

BlackRock is a $4 trillion money manager that runs 7000 different investment strategies. You may know them by their iShares brand of ETFs. One type is enhanced index funds. Some tilt to stocks that are both value and small. Another is a beta strategy that attempts to capture the market. Another is minimum volatility. Another is holding stocks in equal proportion instead by market cap. Another is contrarian underweighting stocks the crowd loves too much. Fundamentals are based on measures such as sales and dividends. Momentum stocks, based on recent price increase where stock price is expected to do well at least for a period of time. Their ETFs usually have low expense ratios and are purchased like stocks. (Money, Jan/Feb. 2014, page 72)

Variability is volatile. Since 1926, stocks were 3.5 times as volatile as bonds. At the time of the 2002 and 2008 financial crises, stocks were 14 times as volatile as bonds. Go to finance.yahoo.com and put in ^GSPC for history of the S&P 500. What is the distribution of standard deviation? See an article in the UMAP Journal at COMAP on this topic.
References:

At Comap.com:

“The Monte Carlo Method and Random Number Generators,” Consortium 56, 1995, COMAP. Com.  See the several references cited on the first page this referenced article.


See Monte Carlo simulations on EXCEL.

In this course under Unit 3: Long-Term Financial Planning, there are five articles on survivability of retirement funds, some of which used Monte Carlo simulations. See those articles.

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