Portfolio Monte Carlo Simulation for Retirement Planning

Author: James Tsay

Created with Python and FPDF

User Guide: Portfolio Monte Carlo Simulation for Retirement Planning

1. Purpose

This Monte Carlo simulation tool is designed to help users plan for retirement by modeling different portfolio allocation scenarios under realistic and uncertain future conditions, such as inflation, taxes, market volatility, and income sources.

It aims to answer questions such as:

- Will I run out of money in retirement?
- How does asset allocation affect my long-term security?
- What impact do stagflation, recessions, or taxes have?

2. Getting Started

Requirements:

- Python 3.x
- Required libraries: numpy, matplotlib, tkinter

Launch:

Run the Python script, and a GUI will open with input fields and simulation controls.

3. Features

- Customizable Inputs: Age, income, spending, debt, asset allocations.
- Tax Awareness: Traditional, Roth, and Taxable accounts with realistic withdrawal tax logic.
- Inflation-Adjusted Projections: Simulates both nominal and real (inflation-adjusted) values.
- Fat-Tail Distributions: Uses Student's t-distribution to capture extreme market volatility.
- Custom Events: Define years of recession or stagflation to simulate economic shocks.
- Debt Modeling: Includes mortgage, student, and credit card debt impacts.
- Account Type Allocations: Assign asset balances to tax-deferred, tax-free, or taxable buckets.
- Export Options: Save input files (JSON) and output results (CSV).

4. Simulation Assumptions

- Simulates 1,000 Monte Carlo paths (configurable in code).
- Asset returns are generated using:
  - Base expected return + fat-tailed shock
  - np.random.standard_t(df=3) * asset volatility
- Returns capped at a minimum per asset (e.g., stocks: -60%, spec: -100%).
- Inflation is compounded yearly and affects spending, income, and social security.
- Recessions and stagflation modify returns for affected assets in those years.

5. How to Use the Tool

Main Inputs Tab:

- Enter starting/ending ages, income details, spending, inflation, etc.
- Specify recession/stagflation years.

Allocations Tab:

- Input asset allocation % and growth rate assumptions.
- Assign percentages to taxable, traditional, and Roth accounts.

Debt Tab:

- Configure mortgage, student loans, and credit card debt with timing and interest rates.

Run Simulation:

- Click 'Run Simulation' to see output charts.
- Use buttons to save results or export inputs to JSON for future reuse.

6. Outputs and Interpretation

After running the simulation, two charts are shown:

- Left Chart: Portfolio value (nominal and real) up to cutoff age (e.g., retirement age).
- Right Chart: Full projection to end of life (age 100).

User Guide: Portfolio Monte Carlo Simulation for Retirement Planning

Each shows:

- 10th percentile: Worst-case scenarios (early depletion)
- 50th percentile: Median outcome
- 90th percentile: Best-case scenarios

Interpret these as a distribution of outcomes - not certainties.

7. Appendix: Numerical Assumptions

Category	Parameter	Value / Source
Returns (normal)	Stocks	7.5%
	Bonds	4.0%
	Cash	3.0%
	Speculative (e.g., crypto)	10.0%
	Gold	4.0%
	REITs	6.0%
Volatility	Stocks	15%
	Speculative	35%
	Bonds	5%
	Cash	1%
	Gold	20%
	REITs	15%
Fat Tail	Degrees of freedom (df)	3
Taxes	Capital Gains (Taxable Account)	15%
	Ordinary Income (Traditional)	22%
Inflation	Annual Inflation Rate	2.5%
Spending	Reduced after mortgage payoff	Customizable

Portfolio Floor	Stocks	-60%
	Speculative	-100%
	Bonds	-20%
	REITs	-80%
	Gold	-50%

8. G

Nominal

Returns or values that are not adjusted for inflation. Represent the actual dollar value.

Real

Returns or values that are adjusted for inflation, reflecting purchasing power.

Monte Carlo Simulation

A statistical technique that models the probability of different outcomes using repeated random sampling.

Fat-Tailed Distribution

A probability distribution with extreme values (like crashes or booms) occurring more often than in a normal distribution.

Taxable, Traditional, Roth

Types of investment accounts with different tax implications. Taxable: gains taxed annually. Traditional: taxed on withdrawal. Roth: tax-free growth and withdrawal.

Withdrawal Rate

Percentage of the portfolio withdrawn annually in retirement.

Percentiles (10th/50th/90th)

Measures of simulation results: 10th = pessimistic, 50th = median, 90th = optimistic outcome.