Modeling Future Uncertainty: MONTE CARLO ANALYSIS

A careful evaluation of your asset allocation and withdrawal rate in retirement is vital. The following tables show how stocks—in varying proportions—coupled with various withdrawal rates could increase the probability of comfortably funding a 25-, 30-, or even 35-year retirement.

For example, the middle table suggests that there is a 90% chance that a mix of 60% stocks and 40% bonds would sustain a 4% withdrawal rate (increased 3% annually for inflation) throughout a 30-year retirement.

<table>
<thead>
<tr>
<th>Withdrawal Rate</th>
<th>Stock/Bond Mix</th>
<th>100/0</th>
<th>80/20</th>
<th>60/40</th>
<th>40/60</th>
<th>20/80</th>
</tr>
</thead>
<tbody>
<tr>
<td>3%</td>
<td></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>92%</td>
<td>94%</td>
<td>97%</td>
<td>98%</td>
<td>98%</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>78%</td>
<td>79%</td>
<td>79%</td>
<td>77%</td>
<td>70%</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>62%</td>
<td>60%</td>
<td>55%</td>
<td>46%</td>
<td>28%</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>47%</td>
<td>41%</td>
<td>32%</td>
<td>20%</td>
<td>5%</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>32%</td>
<td>25%</td>
<td>17%</td>
<td>4%</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Armed with the above, investors can customize an asset mix and withdrawal rate to coincide with their specific requirements.**

IMPORTANT: The information regarding the likelihood of various investment outcomes is hypothetical in nature, does not reflect actual investment results, and is not a guarantee of future results. The simulations are based on a number of assumptions. There can be no assurance that the results shown will be achieved or sustained. The charts present only a range of possible outcomes. Results may vary, and such results may be better or worse than the simulated scenarios. Clients should be aware that the potential for loss (or gain) may be greater than demonstrated in the simulations.

Calculations only considered stock/bond mixes; short-term bonds were not included.

*The likelihood of having at least $1 remaining in the portfolio at the end of the retirement period.*
Monte Carlo Simulation

Monte Carlo simulations model future uncertainty. In contrast to tools generating average outcomes, Monte Carlo analyses produce outcome ranges based on probability, thus incorporating future uncertainty.

MATERIAL ASSUMPTIONS INCLUDE:
- The projections generated by the tool regarding the likelihood of various investment outcomes are based on historical performance data of specific asset classes as described below but are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. The tool presents only a range of possible outcomes. There can be no assurance that the projected or simulated results will be achieved or sustained.
- The hypothetical examples are based on the performance of the S&P 500 Index, which tracks the performance of 500 large-company stocks, and the Bloomberg Barclays U.S. Aggregate Bond Index, which tracks domestic investment-grade bonds, including corporate, government, and mortgage-backed securities, for the time periods represented. Indexes are unmanaged, and it is not possible to invest directly in an index. These hypothetical examples are meant for illustrative purposes only and do not reflect an actual investment, nor do they account for the effects of taxes or any investment expenses. Investment returns are not guaranteed, cannot be predicted, and will fluctuate. All investments are subject to risk, including the possible loss of the money invested.
- These assumptions, as well as an assumed degree of fluctuation of returns around these long-term rates, are used to generate random monthly returns for each asset class over specified time periods.
- The monthly returns are then used to generate thousands of scenarios, representing a spectrum of possible return outcomes for the modeled asset classes. Success rates are based on these scenarios.

MATERIAL LIMITATIONS INCLUDE:
- The analysis relies on return assumptions, combined with a return model that generates a wide range of possible return scenarios from these assumptions. Despite our best efforts, there is no certainty that the assumptions for the model will accurately estimate asset class return rates going forward. As a consequence, the results of the analysis should be viewed as approximations, and users should allow a margin of error and not place too much reliance on the apparent precision of the results.
- Extreme market movements may occur more often than in the model.
- Some asset classes have relatively short histories. Actual long-term results for each asset class may differ from our assumptions, with those for classes with limited histories potentially diverging more.
- Market crises can cause asset classes to perform similarly, lowering the accuracy of our projected return assumptions and diminishing the benefits of diversification (that is, using many different asset classes) in ways not captured by the analysis. As a result, returns actually experienced by the investor may be more volatile than projected in our analysis.
- The model does not take into consideration short-term correlations among asset class returns ("correlation" is a measure of the degree in which returns are related to or dependent upon each other). It does not reflect the average duration of "bull" and "bear" markets, which can be longer than those modeled.
- Inflation is assumed to be constant, so variations are not reflected in our calculations.
- The analysis does not use all asset classes. Other asset classes may provide different returns or outcomes than those used.
- Taxes are not taken into account, nor are early withdrawal penalties.
- The analysis models asset classes, not investment products. As a result, the actual experience of an investor in a given investment product (e.g., a mutual fund) may differ from the range generated by the simulation, even if the broad asset allocation of the investment product is similar to the one being modeled. Possible reasons for divergence include, but are not limited to, active management by the manager of the investment product or the costs, fees, and other expenses associated with the investment product. Active management for any particular investment product—the selection of a portfolio of individual securities that differs from the broad asset classes modeled in the analysis—can lead to the investment product having higher or lower returns than the range in this analysis.

MODEL PORTFOLIO CONSTRUCTION:
Five model investment portfolios were designed by our investment professionals according to the principles of Modern Portfolio Theory, which is used to achieve effective diversification among different asset classes. An effectively diversified portfolio theoretically consists of all investable asset classes, including equities, bonds, real estate, foreign investments, commodities, precious metals, currencies, and others. Since it is unlikely that investors will own all of these assets, we selected the ones we believed to be the most appropriate for long-term investors. The asset classes used for the model portfolios are stocks and bonds.

MODELING ASSUMPTIONS:
- The asset classes used for this analysis are stocks and bonds.
- T. Rowe Price has analyzed a variety of retirement savings strategies using computer simulations to determine the likelihood of "success" (having at least one dollar remaining in the portfolio at the end of the retirement period) of each strategy, shown as a percentage in each grid. The initial withdrawal rate is the percentage of the initial value of the investments withdrawn in the first year where the entire amount is withdrawn on the first day of the year; in each subsequent year, the amount withdrawn is adjusted to reflect a 3% annual rate of inflation. The simulation success rates are based on simulating 1,000 possible future market scenarios and various retirement income strategies.
- Results of the analysis are driven primarily by the assumed long-term compound rates of return of each asset class in the scenarios. Our corresponding assumptions are gross of fees and are as follows: for stocks, 8.3%, and for bonds, 5.0%. These returns do not reflect fees and expenses or the effect of inflation.
- The model reflects returns based on historical periods, benchmarks, and risk-free premia above the risk-free rate (theoretical borrowing rates with zero risk). The modeled returns and other assumption variables, like volatility, are based on benchmarks and model asset classes—therefore, they do not model any individual securities or their associated returns or expenses and fees.

IMPORTANT: The projections or other information generated by the Retirement Income Calculator regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. The simulations are based on assumptions. There can be no assurance that the projected or simulated results will be achieved or sustained. The charts present only a range of possible outcomes. Actual results will vary with each use and over time, and such results may be better or worse than the simulated scenarios. Clients should be aware that the potential for loss (or gain) may be greater than demonstrated in the simulations.

The T. Rowe Price Retirement Income Calculator allows retirement savers to estimate the durability of their current savings across 1,000 randomly generated market scenarios and to assess the impact of different savings rates, time horizons, and asset allocations on the projection of retirement income. The results generated are hypothetical and are not guaranteed.

The results are not predictions, but they should be viewed as reasonable estimates.

T. Rowe Price Investment Services, Inc.