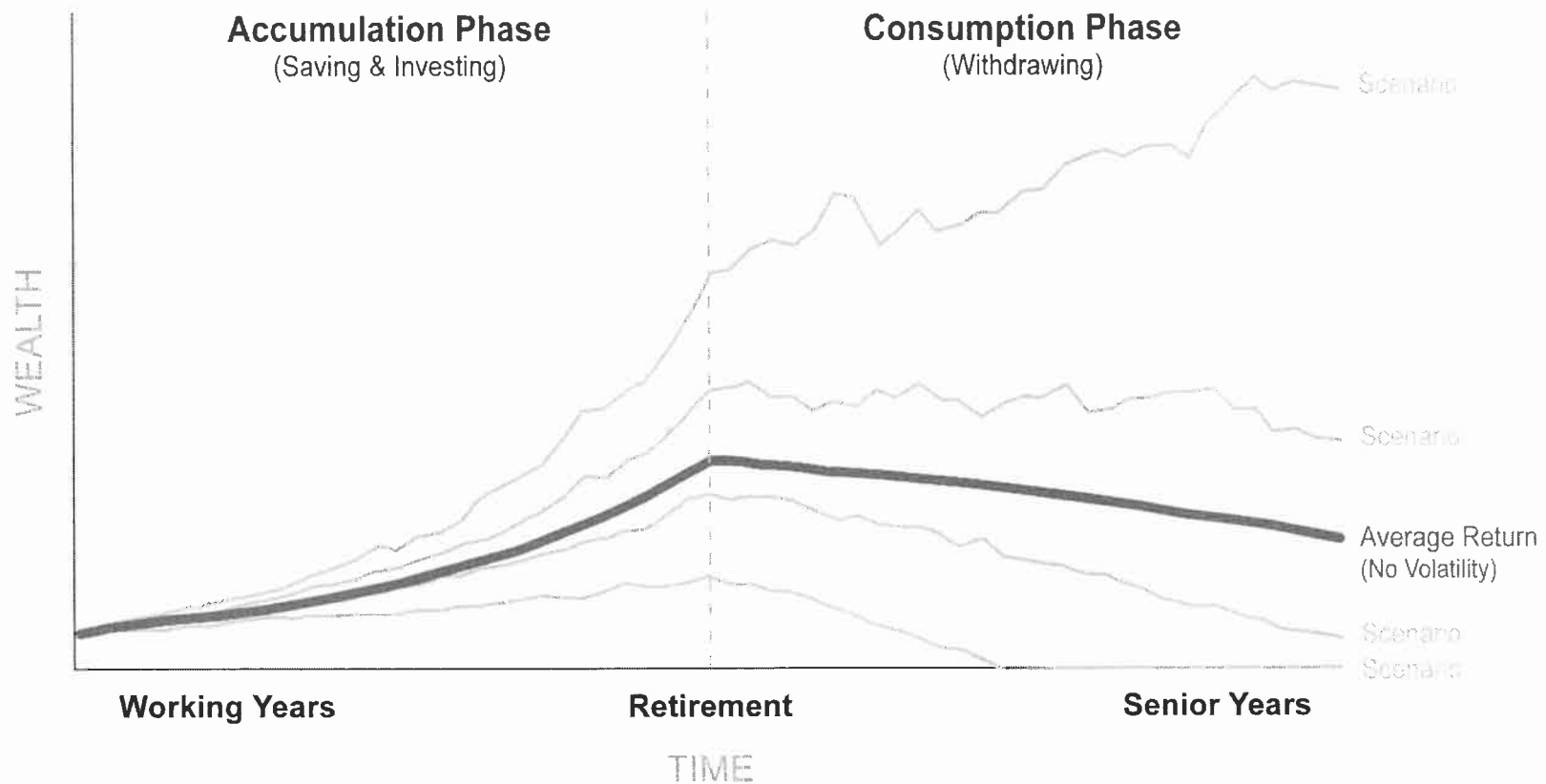


## Retirement Planning Challenge Illustration



This conceptual graph illustrates that all investors face a wide range of potential wealth outcomes in the future. The blue line shows an average return assumption, which does not consider that a portfolio will experience up and down years (volatility) over time. The green lines show only four potential scenarios out of a much larger set of possibilities. The purpose of Monte Carlo simulation is to help investors envision the uncertain future in terms of probabilities. The Monte Carlo technique creates thousands of investment trials (or scenarios) in which the investment parameters (savings and withdrawals) are provided by the client. The investment returns used to generate each trial are drawn from a normal distribution, whose parameters are specified by the client. This is for illustration purposes only and does not reflect an actual or simulated portfolio.

## About the Retirement Planning Challenge Illustration

- Two major phases: accumulation and consumption.
- Save and invest during accumulation; liquidate assets and withdraw cash to fund retirement during consumption phase.
- Manage assets and withdrawals to preserve wealth throughout life.
- Smooth blue line reflects assumed average annual return (no volatility). Does not accurately portray real world conditions.
- The green lines show examples of possible scenarios.
- Monte Carlo method creates thousands of simulations to estimate the probability distribution of wealth through time.
- Using this model, an investor views results from a statistical viewpoint.

## Problems with Average Return Scenario

- Does not offer information on the probabilities of different investment outcomes.
- The average investment path may succeed in providing enough earnings growth for a life-long consumption during retirement, but does not provide guidance on the risks involved (probability of running out of savings).
- The order of the return sequence impacts portfolio value when considering contributions and withdrawals. Using a constant average fails to model this.

## How Monte Carlo Helps

- Estimates how return distribution assumptions (mean and standard deviation of normally distributed returns), accumulation contributions and retirement withdrawals impact wealth over time.
- Provides guidance on the different factors that may increase the probability of success (having enough savings for life-long consumption).

### Monte Carlo Method

- Computational algorithm that provides guidance on the solution of complex stochastic (random through time) problems.<sup>(1)</sup>
- Uses repeated statistical sampling to model uncertainty.
- A scenario aggregates thousands of individual simulations to estimate the probabilities of possible wealth outcomes.
- Using simplifying assumptions, Monte Carlo simulations allow an investor to estimate the likelihood of achieving a wealth goal.
- Each simulation is an investment lifetime of normally distributed random returns.<sup>(2)</sup>
- Not a forecasting or portfolio management tool.

(1) A stochastic problem involves a randomly determined sequence of observations. Each observation is a sample of one element from a probability distribution.

(2) A probability distribution represents all possible values a random variable can assume. It also assigns a probability to observing each value.

## Benefits

- Monte Carlo simulates the potential effects of volatility during an investment lifetime.
- Investor can evaluate and rank probability of experiencing possible wealth outcomes.
- Investor can vary assumptions to compare scenarios.

## Limits and Considerations

- The Monte Carlo distribution of outcomes and implied conclusions are sensitive to input assumptions.
- Assumptions behind inputs may not be realistic.
- Investment returns may not follow a normal distribution, which may impact the simulation outcome, especially with respect to extreme events.
- Monte Carlo simulation does not consider taxation and other important factors that may affect wealth accumulation process.