Monte Carlo: Lump Sum vs Pension

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```r
set.seed(NULL)  # Ensure randomness is not fixed
```

Assumptions

```r
# Assumptions
retirement_age <- 62          # when income begins
max_age <- 100                # hard cap on lifespan
num_sims <- 10000             # number of Monte Carlo runs

lump_sum <- 525000            # pension buyout value
pension_payment <- 42000      # annual pension payment
withdrawal_real <- 42000      # real withdrawal from portfolio

real_return_mean <- 0.06      # expected inflation-adjusted portfolio return.
real_volatility <- 0.12       # annual standard deviation of returns.
real_discount_rate <- 0.03    # used to convert future dollars into today's dollars.
```

Mortality Model

```r
# Mortality Model (Gompertz)
# Approximation for male mortality
# The Gompertz formula models how death probability increases exponentially with age.
gompertz_b <- 0.085
gompertz_m <- 88

simulate_lifespan <- function(start_age) {
  age <- start_age

  while (age < max_age) {
    hazard <- gompertz_b * exp(gompertz_b * (age - gompertz_m)) # Represents mortality intensity.
    death_prob <- 1 - exp(-hazard) # Converts hazard into annual death probability.

    if (runif(1) < death_prob) {
      return(age)
    }

    age <- age + 1
```

```
  }
  # runif(1) draws a random number between 0 and 1.
  # If that number is less than the death probability: death occurs that year

  return(max_age)
}
```

Monte Carlo Simualtion

```
# Storage for results of each simulation
lump_pv_results <- numeric(num_sims)
pension_pv_results <- numeric(num_sims)
```

```
# Monte Carlo Simulation
for (sim in 1:num_sims) {

  death_age <- simulate_lifespan(retirement_age)
  years_alive <- death_age - retirement_age # Determines how many years of income is received

  # Lump Sum Strategy
  portfolio <- lump_sum
  lump_pv <- 0

  for (year in 1:years_alive) {

    annual_return <- rnorm(1, real_return_mean, real_volatility) # Generate random return
    portfolio <- portfolio * (1 + annual_return) # Compund assets

    withdrawal <- min(withdrawal_real, portfolio) # Withdraw $42k (or remaining balance if depleted)
    portfolio <- portfolio - withdrawal

    # Convert future withdrawal into today's dollars
    lump_pv <- lump_pv + withdrawal / ((1 + real_discount_rate)^year)

    if (portfolio <= 0) break
  }
     if (portfolio > 0) {
    lump_pv <- lump_pv + portfolio / ((1 + real_discount_rate)^years_alive) # Captures estate value
  }

  # Pension Strategy
  pension_pv <- 0

  for (year in 1:years_alive) {
    pension_pv <- pension_pv +
      pension_payment / ((1 + real_discount_rate)^year)
  }

  # Store results
  lump_pv_results[sim] <- lump_pv
  pension_pv_results[sim] <- pension_pv
```

```r
}
```

Results

```r
# Results
cat("----- Lump Sum Strategy (Real PV) -----\n")
```

```
## ----- Lump Sum Strategy (Real PV) -----
```

```r
cat("Average PV:", round(mean(lump_pv_results), 0), "\n")
```

```
## Average PV: 704926
```

```r
cat("Median PV:", round(median(lump_pv_results), 0), "\n")
```

```
## Median PV: 627565
```

```r
cat("Std Dev:", round(sd(lump_pv_results), 0), "\n\n")
```

```
## Std Dev: 307958
```

```r
cat("----- Pension Strategy (Real PV) -----\n")
```

```
## ----- Pension Strategy (Real PV) -----
```

```r
cat("Average PV:", round(mean(pension_pv_results), 0), "\n")
```

```
## Average PV: 649716
```

```r
cat("Median PV:", round(median(pension_pv_results), 0), "\n")
```

```
## Median PV: 711293
```

```r
cat("Std Dev:", round(sd(pension_pv_results), 0), "\n\n")
```

```
## Std Dev: 233029
```

```r
cat("Probability Lump Sum Wins:",
    round(mean(lump_pv_results > pension_pv_results) * 100, 2), "%\n")
```

```
## Probability Lump Sum Wins: 51.17 %
```

Lump Sum Results

- The **average is higher than the median**. That tells us the distribution is **right-skewed** where a smaller number of strong market scenarios are pulling the mean up but most outcomes are closer to the median.
- **High standard deviation** reflects a high market volatility.

Pension Results

- The **median is higher than the average**. That tells us some early death scenarios **drag down the average** but most outcomes are closer to the median.
- Standard deviation is large but is lower than the standard deviation of the lump sum method.

There is not a dominant strategy either way.

The decision depends heavily on:

- **Risk tolerance**
- **Health**
- **Desire for guaranteed income**
- **Behavioral discipline**
- **Legacy goals**

Pension is better if:

- You expect to live a long time
- You value guaranteed income
- You prefer certainty
- You don't need liquidity
- You want longevity insurance

Lump Sum may be better if:

- You are in poor health
- You want estate value
- You want flexibility
- You are comfortable with volatility