**Unit 5 - Financial Planning**

**[1]:**

*# Initial imports*

**import** os

**import** requests

**import** pandas **as** pd

**from** dotenv **import** load\_dotenv

**import** alpaca\_trade\_api **as** tradeapi

**from** MCForecastTools **import** MCSimulation

​

**%**matplotlib inline

[2]:

*# Load .env enviroment variables*

load\_dotenv()

**[2]:**

True

**Part 1 - Personal Finance Planner**

**[3]:**

*# Set monthly household income*

*# YOUR CODE HERE!*

**Collect Crypto Prices Using the requests Library**

**[4]:**

*# Current amount of crypto assets*

my\_btc **=** 1.2

my\_eth **=** 5.3

**[5]:**

*# Crypto API URLs*

btc\_url **=** "https://api.alternative.me/v2/ticker/Bitcoin/?convert=USD"

eth\_url **=** "https://api.alternative.me/v2/ticker/Ethereum/?convert=USD"

**[6]:**

*# Fetch current BTC price*

*# YOUR CODE HERE!*

​

*# Fetch current ETH price*

*# YOUR CODE HERE!]*

​

*# Compute current value of my crpto*

*# YOUR CODE HERE!*

​

*# Print current crypto wallet balance*

print(f"The current value of your {my\_btc} BTC is ${my\_btc\_value:0.2f}")

print(f"The current value of your {my\_eth} ETH is ${my\_eth\_value:0.2f}")

The current value of your 1.2 BTC is $14309.16

The current value of your 5.3 ETH is $2096.47

**Collect Investments Data Using Alpaca: SPY (stocks) and AGG (bonds)**

**[7]:**

*# Current amount of shares*

my\_agg **=** 200

my\_spy **=** 50

**[8]:**

*# Set Alpaca API key and secret*

*# YOUR CODE HERE!*

​

*# Create the Alpaca API object*

*# YOUR CODE HERE!*

**[9]:**

*# Format current date as ISO format*

*# YOUR CODE HERE!*

​

*# Set the tickers*

tickers **=** ["AGG", "SPY"]

​

*# Set timeframe to '1D' for Alpaca API*

timeframe **=** "1D"

​

*# Get current closing prices for SPY and AGG*

*# YOUR CODE HERE!*

​

*# Pick AGG and SPY close prices*

*# YOUR CODE HERE!*

​

*# Print AGG and SPY close prices*

print(f"Current AGG closing price: ${agg\_close\_price}")

print(f"Current SPY closing price: ${spy\_close\_price}")

Current AGG closing price: $119.445

Current SPY closing price: $334.55

**[10]:**

*# Compute the current value of shares*

*# YOUR CODE HERE!*

​

*# Print current value of share*

print(f"The current value of your {my\_spy} SPY shares is ${my\_spy\_value:0.2f}")

print(f"The current value of your {my\_agg} AGG shares is ${my\_agg\_value:0.2f}")

The current value of your 50 SPY shares is $16727.50

The current value of your 200 AGG shares is $23889.00

**Savings Health Analysis**

**[11]:**

*# Create savings DataFrame*

*# YOUR CODE HERE!*

​

*# Display savings DataFrame*

display(df\_savings)

|  | **amount** |
| --- | --- |
| **crypto** | 16405.628 |
| **shares** | 40616.500 |

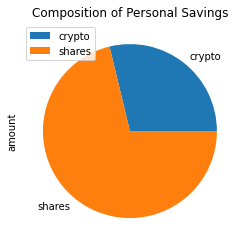
[12]:

*# Plot savings pie chart*

*# YOUR CODE HERE!*

**[12]:**

<matplotlib.axes.\_subplots.AxesSubplot at 0x7f9fdc2a1710>



**[13]:**

*# Set ideal emergency fund*

emergency\_fund **=** monthly\_income **\*** 3

​

*# Calculate total amount of savings*

*# YOUR CODE HERE!*

​

*# Validate saving health*

*# YOUR CODE HERE!*

Congratulations! You have enough money in your emergency fund.

**Part 2 - Retirement Planning**

**Monte Carlo Simulation**

**[14]:**

*# Set start and end dates of five years back from today.*

*# Sample results may vary from the solution based on the time frame chosen*

start\_date **=** pd.Timestamp('2015-08-07', tz**=**'America/New\_York').isoformat()

end\_date **=** pd.Timestamp('2020-08-07', tz**=**'America/New\_York').isoformat()

**[15]:**

*# Get 5 years' worth of historical data for SPY and AGG*

*# YOUR CODE HERE!*

​

*# Display sample data*

df\_stock\_data.head()

**[15]:**

|  | **AGG** | | | | | **SPY** | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **open** | **high** | **low** | **close** | **volume** | **open** | **high** | **low** | **close** | **volume** |
| **2015-08-07 00:00:00-04:00** | 109.14 | 109.2750 | 109.035 | 109.21 | 2041167.0 | 208.16 | 208.34 | 206.87 | 207.93 | 87669782 |
| **2015-08-10 00:00:00-04:00** | 109.15 | 109.1700 | 108.920 | 109.06 | 1149778.0 | 209.28 | 210.67 | 209.28 | 210.58 | 66755890 |
| **2015-08-11 00:00:00-04:00** | 109.42 | 109.5765 | 109.284 | 109.42 | 1420907.0 | 208.98 | 209.47 | 207.76 | 208.63 | 88424557 |
| **2015-08-12 00:00:00-04:00** | 109.55 | 109.7100 | 109.350 | 109.36 | 1468979.0 | 207.11 | 209.14 | 205.36 | 208.89 | 136171450 |
| **2015-08-13 00:00:00-04:00** | 109.36 | 109.3651 | 109.110 | 109.15 | 1465173.0 | 208.73 | 209.55 | 208.01 | 208.63 | 77197796 |

[16]:

*# Configuring a Monte Carlo simulation to forecast 30 years cumulative returns*

*# YOUR CODE HERE!*

[17]:

*# Printing the simulation input data*

*# YOUR CODE HERE!*

[17]:

|  | **AGG** | | | | | | **SPY** | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **open** | **high** | **low** | **close** | **volume** | **daily\_return** | **open** | **high** | **low** | **close** | **volume** | **daily\_return** |
| **2015-08-07 00:00:00-04:00** | 109.14 | 109.2750 | 109.035 | 109.21 | 2041167.0 | NaN | 208.16 | 208.34 | 206.87 | 207.93 | 87669782 | NaN |
| **2015-08-10 00:00:00-04:00** | 109.15 | 109.1700 | 108.920 | 109.06 | 1149778.0 | -0.001374 | 209.28 | 210.67 | 209.28 | 210.58 | 66755890 | 0.012745 |
| **2015-08-11 00:00:00-04:00** | 109.42 | 109.5765 | 109.284 | 109.42 | 1420907.0 | 0.003301 | 208.98 | 209.47 | 207.76 | 208.63 | 88424557 | -0.009260 |
| **2015-08-12 00:00:00-04:00** | 109.55 | 109.7100 | 109.350 | 109.36 | 1468979.0 | -0.000548 | 207.11 | 209.14 | 205.36 | 208.89 | 136171450 | 0.001246 |
| **2015-08-13 00:00:00-04:00** | 109.36 | 109.3651 | 109.110 | 109.15 | 1465173.0 | -0.001920 | 208.73 | 209.55 | 208.01 | 208.63 | 77197796 | -0.001245 |

[18]:

*# Running a Monte Carlo simulation to forecast 30 years cumulative returns*

*# YOUR CODE HERE!*

Running Monte Carlo simulation number 0.

Running Monte Carlo simulation number 10.

Running Monte Carlo simulation number 20.

Running Monte Carlo simulation number 30.

Running Monte Carlo simulation number 40.

Running Monte Carlo simulation number 50.

Running Monte Carlo simulation number 60.

Running Monte Carlo simulation number 70.

Running Monte Carlo simulation number 80.

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Running Monte Carlo simulation number 100.

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Running Monte Carlo simulation number 410.

Running Monte Carlo simulation number 420.

Running Monte Carlo simulation number 430.

Running Monte Carlo simulation number 440.

Running Monte Carlo simulation number 450.

Running Monte Carlo simulation number 460.

Running Monte Carlo simulation number 470.

Running Monte Carlo simulation number 480.

Running Monte Carlo simulation number 490.

[18]:

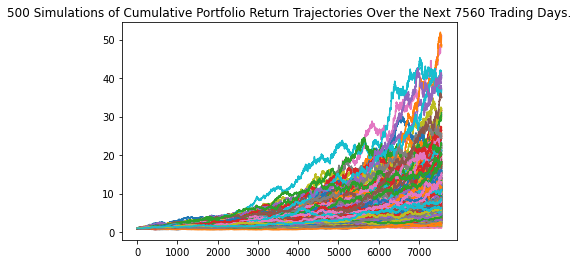
|  | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **...** | **490** | **491** | **492** | **493** | **494** | **495** | **496** | **497** | **498** | **499** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | ... | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 |
| **1** | 1.018353 | 0.990991 | 0.993542 | 1.004285 | 1.010543 | 0.996096 | 1.004661 | 1.009838 | 1.000822 | 0.996604 | ... | 0.989897 | 1.000037 | 1.012813 | 1.001722 | 1.000656 | 1.002117 | 1.003528 | 1.002606 | 0.991949 | 0.997364 |
| **2** | 1.014560 | 0.992820 | 0.996145 | 1.002978 | 1.005147 | 1.004685 | 1.001202 | 1.010342 | 0.993041 | 0.992330 | ... | 0.988645 | 1.007607 | 1.020869 | 1.005857 | 1.006082 | 0.996915 | 1.004331 | 0.990710 | 0.987952 | 0.991272 |
| **3** | 1.019269 | 1.001492 | 1.009462 | 1.014306 | 1.001689 | 1.025238 | 0.996099 | 1.011401 | 0.994015 | 0.994844 | ... | 0.986177 | 1.005196 | 1.031488 | 1.005400 | 1.002427 | 0.999050 | 1.002731 | 0.979590 | 0.999434 | 0.989640 |
| **4** | 1.014859 | 1.003336 | 1.004606 | 1.019190 | 1.003226 | 1.018442 | 0.993964 | 1.005165 | 1.001041 | 1.002201 | ... | 0.992091 | 1.001366 | 1.029699 | 1.021144 | 0.997660 | 1.006650 | 0.990625 | 0.980227 | 1.004842 | 0.984748 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **7556** | 13.864071 | 6.077511 | 11.731330 | 31.243365 | 30.053930 | 14.757036 | 2.210814 | 15.528460 | 7.255163 | 16.637307 | ... | 5.822107 | 2.259562 | 3.783502 | 5.828729 | 4.720930 | 35.072331 | 14.912683 | 5.653658 | 5.648629 | 6.315486 |
| **7557** | 13.746201 | 6.059207 | 11.585533 | 31.287242 | 30.582049 | 14.673008 | 2.186417 | 15.436076 | 7.339485 | 16.766272 | ... | 5.823840 | 2.253127 | 3.775175 | 5.815855 | 4.766911 | 35.030715 | 15.116486 | 5.676312 | 5.688687 | 6.379419 |
| **7558** | 13.599568 | 6.013279 | 11.615333 | 31.745904 | 30.424040 | 14.651556 | 2.171581 | 15.329036 | 7.283202 | 16.707132 | ... | 5.856829 | 2.229323 | 3.777023 | 5.802119 | 4.840632 | 35.167994 | 15.167563 | 5.681892 | 5.727080 | 6.358350 |
| **7559** | 13.777501 | 5.987253 | 11.684295 | 31.652897 | 30.570575 | 14.567353 | 2.180296 | 15.222299 | 7.293879 | 16.740933 | ... | 5.890849 | 2.237878 | 3.812925 | 5.792500 | 4.856454 | 34.870746 | 15.323380 | 5.679676 | 5.710282 | 6.373808 |
| **7560** | 13.797608 | 5.990874 | 11.683965 | 31.599752 | 30.432076 | 14.479116 | 2.200144 | 15.233276 | 7.303912 | 16.756515 | ... | 5.900159 | 2.221008 | 3.840263 | 5.855725 | 4.790127 | 34.967825 | 15.355808 | 5.619571 | 5.727143 | 6.340223 |

7561 rows × 500 columns

[19]:

*# Plot simulation outcomes*

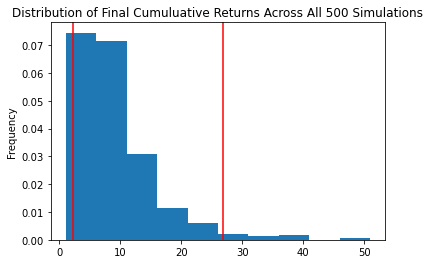
*# YOUR CODE HERE!*



[20]:

*# Plot probability distribution and confidence intervals*

*# YOUR CODE HERE!*



**Retirement Analysis**

[21]:

*# Fetch summary statistics from the Monte Carlo simulation results*

*# YOUR CODE HERE!*

​

*# Print summary statistics*

print(tbl)

count 500.000000

mean 9.200762

std 6.659594

min 1.045214

25% 4.941116

50% 7.381182

75% 11.327780

max 50.993592

95% CI Lower 2.296975

95% CI Upper 26.810558

Name: 7560, dtype: float64

**Given an initial investment of $20,000, what is the expected portfolio return in dollars at the 95% lower and upper confidence intervals?**

[22]:

*# Set initial investment*

initial\_investment **=** 20000

​

*# Use the lower and upper `95%` confidence intervals to calculate the range of the possible outcomes of our $20,000*

*# YOUR CODE HERE!*

​

*# Print results*

print(f"There is a 95% chance that an initial investment of ${initial\_investment} in the portfolio"

f" over the next 30 years will end within in the range of"

f" ${ci\_lower} and ${ci\_upper}")

There is a 95% chance that an initial investment of $20000 in the portfolio over the next 30 years will end within in the range of $45939.5 and $536211.17

**How would a 50% increase in the initial investment amount affect the expected portfolio return in dollars at the 95% lower and upper confidence intervals?**

[23]:

*# Set initial investment*

initial\_investment **=** 20000 **\*** 1.5

​

*# Use the lower and upper `95%` confidence intervals to calculate the range of the possible outcomes of our $30,000*

*# YOUR CODE HERE!*

​

*# Print results*

print(f"There is a 95% chance that an initial investment of ${initial\_investment} in the portfolio"

f" over the next 30 years will end within in the range of"

f" ${ci\_lower} and ${ci\_upper}")

There is a 95% chance that an initial investment of $30000.0 in the portfolio over the next 30 years will end within in the range of $68909.24 and $804316.75

**Optional Challenge - Early Retirement**

**Five Years Retirement Option**

[24]:

*# Configuring a Monte Carlo simulation to forecast 5 years cumulative returns*

*# YOUR CODE HERE!*

[25]:

*# Running a Monte Carlo simulation to forecast 5 years cumulative returns*

*# YOUR CODE HERE!*

Running Monte Carlo simulation number 0.

Running Monte Carlo simulation number 10.

Running Monte Carlo simulation number 20.

Running Monte Carlo simulation number 30.

Running Monte Carlo simulation number 40.

Running Monte Carlo simulation number 50.

Running Monte Carlo simulation number 60.

Running Monte Carlo simulation number 70.

Running Monte Carlo simulation number 80.

Running Monte Carlo simulation number 90.

Running Monte Carlo simulation number 100.

Running Monte Carlo simulation number 110.

Running Monte Carlo simulation number 120.

Running Monte Carlo simulation number 130.

Running Monte Carlo simulation number 140.

Running Monte Carlo simulation number 150.

Running Monte Carlo simulation number 160.

Running Monte Carlo simulation number 170.

Running Monte Carlo simulation number 180.

Running Monte Carlo simulation number 190.

Running Monte Carlo simulation number 200.

Running Monte Carlo simulation number 210.

Running Monte Carlo simulation number 220.

Running Monte Carlo simulation number 230.

Running Monte Carlo simulation number 240.

Running Monte Carlo simulation number 250.

Running Monte Carlo simulation number 260.

Running Monte Carlo simulation number 270.

Running Monte Carlo simulation number 280.

Running Monte Carlo simulation number 290.

Running Monte Carlo simulation number 300.

Running Monte Carlo simulation number 310.

Running Monte Carlo simulation number 320.

Running Monte Carlo simulation number 330.

Running Monte Carlo simulation number 340.

Running Monte Carlo simulation number 350.

Running Monte Carlo simulation number 360.

Running Monte Carlo simulation number 370.

Running Monte Carlo simulation number 380.

Running Monte Carlo simulation number 390.

Running Monte Carlo simulation number 400.

Running Monte Carlo simulation number 410.

Running Monte Carlo simulation number 420.

Running Monte Carlo simulation number 430.

Running Monte Carlo simulation number 440.

Running Monte Carlo simulation number 450.

Running Monte Carlo simulation number 460.

Running Monte Carlo simulation number 470.

Running Monte Carlo simulation number 480.

Running Monte Carlo simulation number 490.

[25]:

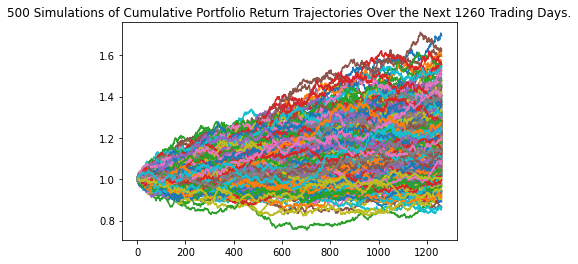
|  | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **...** | **490** | **491** | **492** | **493** | **494** | **495** | **496** | **497** | **498** | **499** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | ... | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 |
| **1** | 1.002773 | 0.995921 | 0.995673 | 0.994602 | 1.005021 | 0.998532 | 1.001126 | 1.005124 | 0.994500 | 0.999171 | ... | 1.002697 | 1.007377 | 0.999067 | 0.997822 | 0.998338 | 1.003092 | 0.997770 | 1.005395 | 0.999348 | 1.005300 |
| **2** | 1.004519 | 0.994920 | 0.995504 | 0.997885 | 0.999418 | 1.002665 | 0.998714 | 1.009062 | 0.992389 | 0.997706 | ... | 1.004034 | 1.008911 | 0.999323 | 1.000654 | 0.999466 | 1.004265 | 0.994733 | 1.003748 | 0.996511 | 1.012382 |
| **3** | 1.003420 | 0.989709 | 0.994363 | 1.001670 | 1.004349 | 1.002377 | 1.001845 | 1.011481 | 0.991912 | 0.994580 | ... | 1.002351 | 1.006664 | 1.002174 | 0.998934 | 1.003854 | 1.010202 | 0.996131 | 1.002018 | 0.999665 | 1.014892 |
| **4** | 0.999165 | 0.990064 | 0.986792 | 1.003455 | 1.007765 | 1.007514 | 0.997581 | 1.015886 | 0.986637 | 0.998216 | ... | 1.002834 | 0.999865 | 1.000353 | 1.003079 | 1.003303 | 1.012221 | 0.997754 | 1.000544 | 1.001517 | 1.013704 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **1256** | 1.266580 | 1.196174 | 1.233861 | 1.609848 | 1.173492 | 1.242440 | 1.329611 | 1.157732 | 1.354542 | 0.980124 | ... | 1.193369 | 1.265576 | 1.176646 | 1.146853 | 1.214548 | 1.145207 | 1.193672 | 1.131104 | 1.003777 | 1.234636 |
| **1257** | 1.259830 | 1.201814 | 1.231141 | 1.621046 | 1.172662 | 1.239173 | 1.331916 | 1.157722 | 1.354061 | 0.980815 | ... | 1.194320 | 1.269009 | 1.182694 | 1.146907 | 1.213701 | 1.143455 | 1.200143 | 1.131160 | 1.006530 | 1.234546 |
| **1258** | 1.265916 | 1.196261 | 1.226184 | 1.622075 | 1.174943 | 1.240829 | 1.335755 | 1.157986 | 1.350916 | 0.981539 | ... | 1.203336 | 1.271746 | 1.178878 | 1.148263 | 1.213656 | 1.146064 | 1.197322 | 1.134041 | 1.005902 | 1.236184 |
| **1259** | 1.268268 | 1.202293 | 1.223321 | 1.623647 | 1.170809 | 1.248084 | 1.336792 | 1.162289 | 1.341674 | 0.977214 | ... | 1.200892 | 1.273981 | 1.175435 | 1.145972 | 1.210717 | 1.146312 | 1.194024 | 1.132655 | 1.007751 | 1.242664 |
| **1260** | 1.275078 | 1.204666 | 1.221803 | 1.620920 | 1.170916 | 1.244088 | 1.333824 | 1.162788 | 1.346848 | 0.974308 | ... | 1.198225 | 1.272588 | 1.179043 | 1.141526 | 1.218961 | 1.151264 | 1.193754 | 1.134594 | 1.007345 | 1.243278 |

1261 rows × 500 columns

[26]:

*# Plot simulation outcomes*

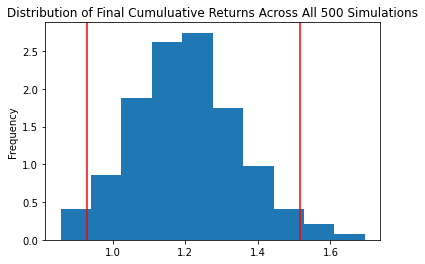
*# YOUR CODE HERE!*



[27]:

*# Plot probability distribution and confidence intervals*

*# YOUR CODE HERE!*



[28]:

*# Fetch summary statistics from the Monte Carlo simulation results*

*# YOUR CODE HERE!*

​

*# Print summary statistics*

print(tbl\_five)

count 500.000000

mean 1.202273

std 0.145565

min 0.856322

25% 1.100622

50% 1.197687

75% 1.292270

max 1.695081

95% CI Lower 0.928556

95% CI Upper 1.517173

Name: 1260, dtype: float64

[29]:

*# Set initial investment*

*# YOUR CODE HERE!*

​

*# Use the lower and upper `95%` confidence intervals to calculate the range of the possible outcomes of our $60,000*

*# YOUR CODE HERE!*

​

*# Print results*

print(f"There is a 95% chance that an initial investment of ${initial\_investment} in the portfolio"

f" over the next 5 years will end within in the range of"

f" ${ci\_lower\_five} and ${ci\_upper\_five}")

There is a 95% chance that an initial investment of $60000 in the portfolio over the next 30 years will end within in the range of $55713.36 and $91030.38

**Ten Years Retirement Option**

[30]:

*# Configuring a Monte Carlo simulation to forecast 10 years cumulative returns*

*# YOUR CODE HERE!*

[31]:

*# Running a Monte Carlo simulation to forecast 10 years cumulative returns*

*# YOUR CODE HERE!*

Running Monte Carlo simulation number 0.

Running Monte Carlo simulation number 10.

Running Monte Carlo simulation number 20.

Running Monte Carlo simulation number 30.

Running Monte Carlo simulation number 40.

Running Monte Carlo simulation number 50.

Running Monte Carlo simulation number 60.

Running Monte Carlo simulation number 70.

Running Monte Carlo simulation number 80.

Running Monte Carlo simulation number 90.

Running Monte Carlo simulation number 100.

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Running Monte Carlo simulation number 460.

Running Monte Carlo simulation number 470.

Running Monte Carlo simulation number 480.

Running Monte Carlo simulation number 490.

[31]:

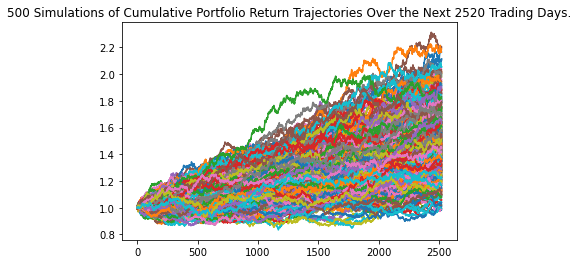
|  | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **...** | **490** | **491** | **492** | **493** | **494** | **495** | **496** | **497** | **498** | **499** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | ... | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 |
| **1** | 0.997817 | 0.998428 | 1.000816 | 1.000202 | 1.002120 | 0.998788 | 1.004226 | 1.004250 | 1.001431 | 1.000740 | ... | 0.995519 | 1.001253 | 1.000492 | 0.994026 | 1.006129 | 1.002356 | 1.005233 | 0.999769 | 1.002106 | 1.003746 |
| **2** | 0.994703 | 0.996223 | 1.001987 | 0.998816 | 1.002372 | 0.996708 | 1.009074 | 1.006986 | 1.006219 | 0.995591 | ... | 0.991815 | 1.001091 | 1.003774 | 0.989341 | 1.007530 | 1.009809 | 1.007273 | 0.999666 | 1.006340 | 0.998303 |
| **3** | 0.994115 | 0.993375 | 0.992622 | 1.001069 | 0.999700 | 1.000123 | 1.011610 | 1.009254 | 1.012194 | 0.998619 | ... | 0.992699 | 1.003085 | 1.005997 | 0.991536 | 1.004239 | 1.010765 | 1.009501 | 0.999652 | 1.011737 | 0.998762 |
| **4** | 0.999040 | 0.997821 | 0.992272 | 0.999767 | 1.000459 | 1.006178 | 1.008906 | 1.009897 | 1.014282 | 0.995619 | ... | 0.997683 | 1.007825 | 1.007858 | 0.991188 | 1.009171 | 1.009303 | 1.008223 | 1.003270 | 1.014350 | 1.001691 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2516** | 2.164254 | 1.246948 | 1.441080 | 1.685210 | 1.702114 | 1.474774 | 1.535126 | 1.288182 | 1.138653 | 1.500977 | ... | 1.367442 | 1.357662 | 1.661583 | 1.348599 | 1.649220 | 1.782632 | 1.450872 | 1.701338 | 1.199957 | 1.171159 |
| **2517** | 2.169555 | 1.246315 | 1.436260 | 1.685058 | 1.697652 | 1.479128 | 1.536203 | 1.288485 | 1.144082 | 1.498097 | ... | 1.366833 | 1.360457 | 1.672969 | 1.351751 | 1.646287 | 1.781356 | 1.459438 | 1.695322 | 1.197466 | 1.171882 |
| **2518** | 2.169089 | 1.243387 | 1.426446 | 1.685480 | 1.714264 | 1.479079 | 1.537777 | 1.289258 | 1.140795 | 1.496271 | ... | 1.368088 | 1.357853 | 1.662915 | 1.354957 | 1.637911 | 1.781046 | 1.451367 | 1.695901 | 1.201111 | 1.172847 |
| **2519** | 2.170695 | 1.238881 | 1.419187 | 1.670521 | 1.720418 | 1.478161 | 1.544292 | 1.296500 | 1.137510 | 1.499085 | ... | 1.370125 | 1.359697 | 1.664317 | 1.352170 | 1.633762 | 1.778638 | 1.443413 | 1.699061 | 1.191529 | 1.166331 |
| **2520** | 2.166411 | 1.238568 | 1.422756 | 1.668923 | 1.720600 | 1.480128 | 1.538224 | 1.292365 | 1.138481 | 1.501295 | ... | 1.368816 | 1.361692 | 1.666635 | 1.349637 | 1.633255 | 1.781666 | 1.442561 | 1.699977 | 1.197157 | 1.165888 |

2521 rows × 500 columns

[32]:

*# Plot simulation outcomes*

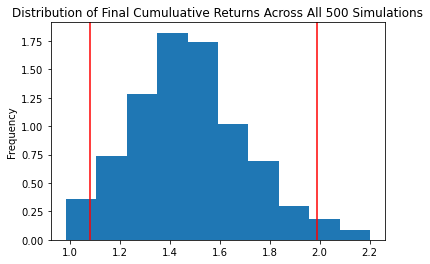
*# YOUR CODE HERE!*



[33]:

*# Plot probability distribution and confidence intervals*

*# YOUR CODE HERE!*



[34]:

*# Fetch summary statistics from the Monte Carlo simulation results*

*# YOUR CODE HERE!*

​

*# Print summary statistics*

print(tbl\_ten)

count 500.000000

mean 1.477364

std 0.230147

min 0.984413

25% 1.319127

50% 1.468676

75% 1.613270

max 2.202006

95% CI Lower 1.083048

95% CI Upper 1.990417

Name: 2520, dtype: float64

[35]:

*# Set initial investment*

*# YOUR CODE HERE!*

​

*# Use the lower and upper `95%` confidence intervals to calculate the range of the possible outcomes of our $60,000*

*# YOUR CODE HERE!*

​

*# Print results*

print(f"There is a 95% chance that an initial investment of ${initial\_investment} in the portfolio"

f" over the next 10 years will end within in the range of"

f" ${ci\_lower\_ten} and ${ci\_upper\_ten}")

There is a 95% chance that an initial investment of $60000 in the portfolio over the next 30 years will end within in the range of $64982.9 and $119425.0