

ProFolio

Volatility Primer

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Introduction

Volatility Background

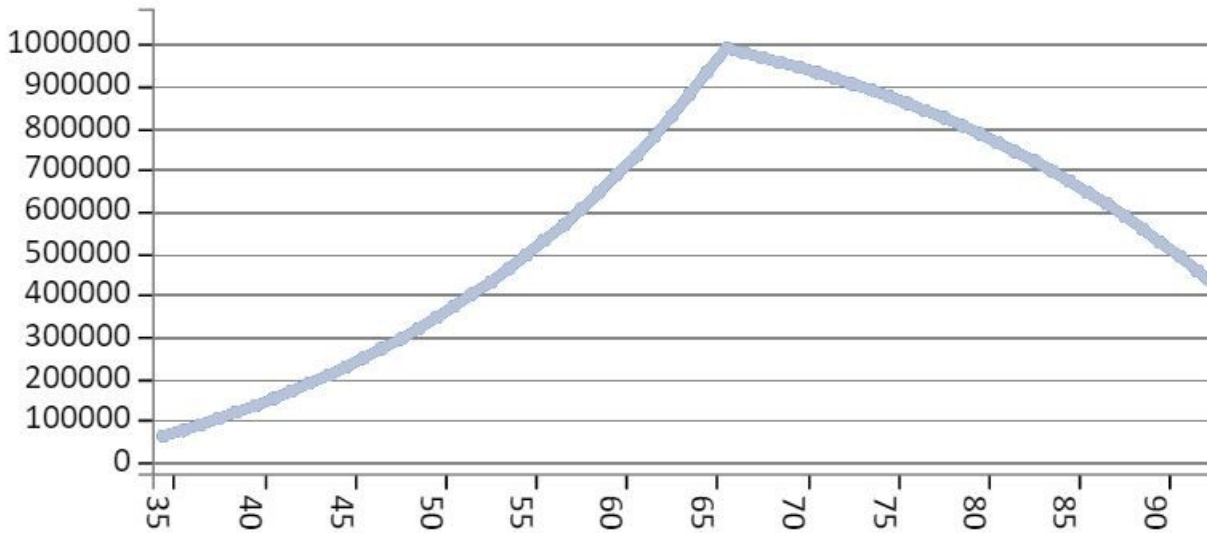
Volatility is a statistical measure of the variability of returns in a given asset or index. Volatility of returns is extremely important in calculating the probability of a future value of a portfolio, such as a retirement portfolio, which is used to generate an income stream. For example, when using a specific return, without factoring the affects of volatility, a retirement account may have an exact 100% chance of meeting a specific goal. Factoring the effects of volatility, or variation in returns, immediately reduces the probability of meeting that goal to 50% since returns have an equal probability of being above or below the average return.

The simplest way to show the effects of volatility is to plot possible portfolio values in a hypothetical retirement account for different levels of volatility using the [ProFolio Retirement Calculator](#).

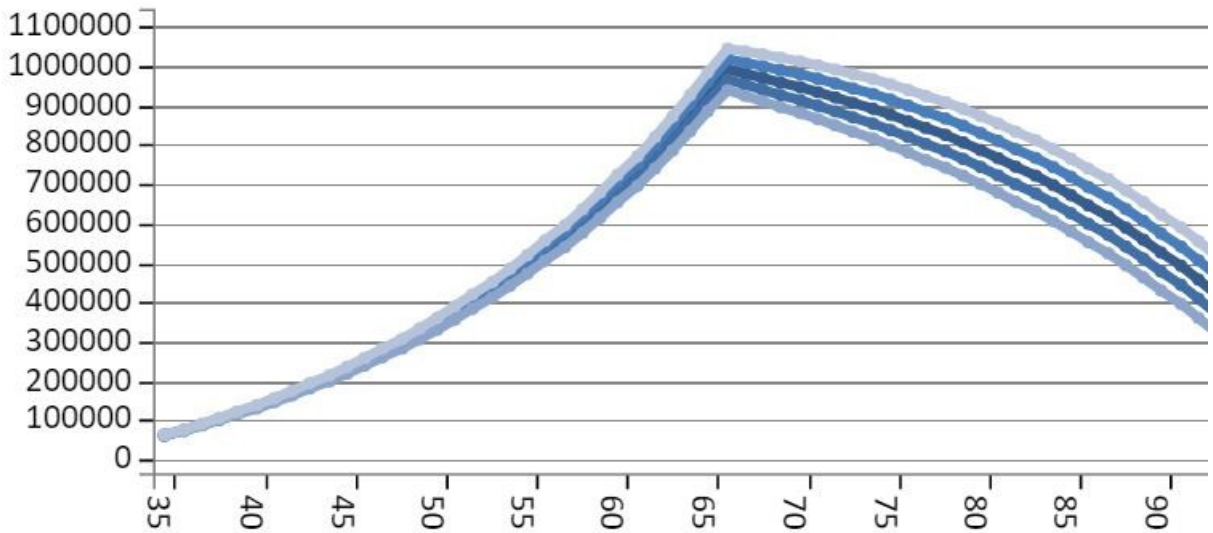
Each of the retirement accounts have an initial starting value of \$50,000 earning an annual return of 5% with an annual contribution of \$10,000 until retirement age. Withdrawals from the portfolio consist of \$60,000 beginning at the retirement age of 67. The only difference in each of the graphs is the amount of volatility.

Each graph contains 5 lines. The middle line is the mean return. The portfolio return has a 50% probability of being above this value and a 50% probability of being below this value regardless of the volatility. The other lines above and below the mean return are equal probability lines (plus and minus one and two standard deviations from the mean).

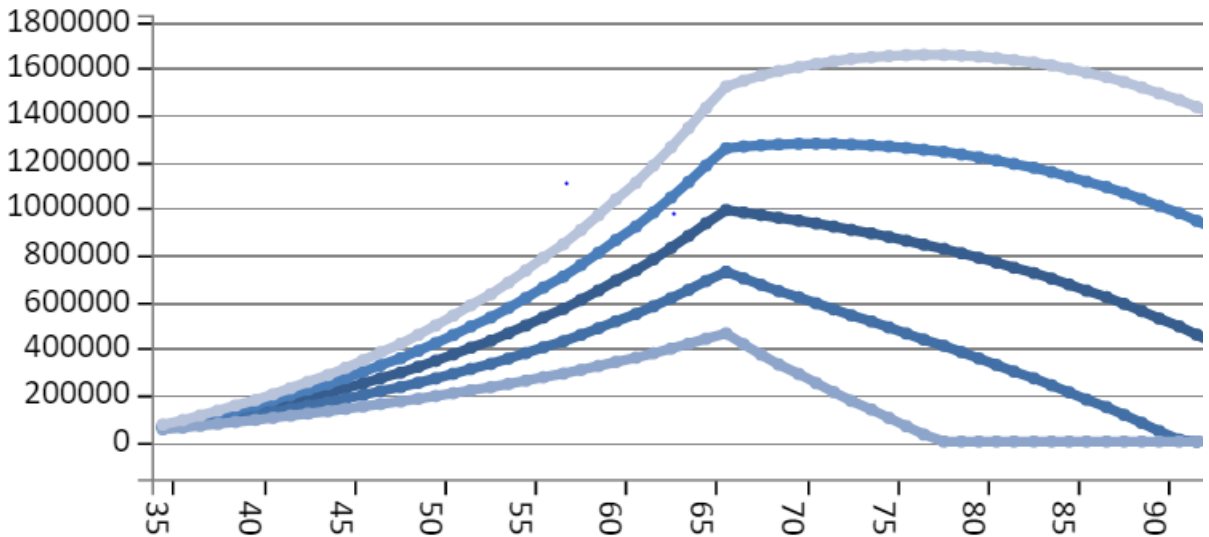
Here is the plot of different possible portfolio values with 0% volatility. Cash has 0% volatility.



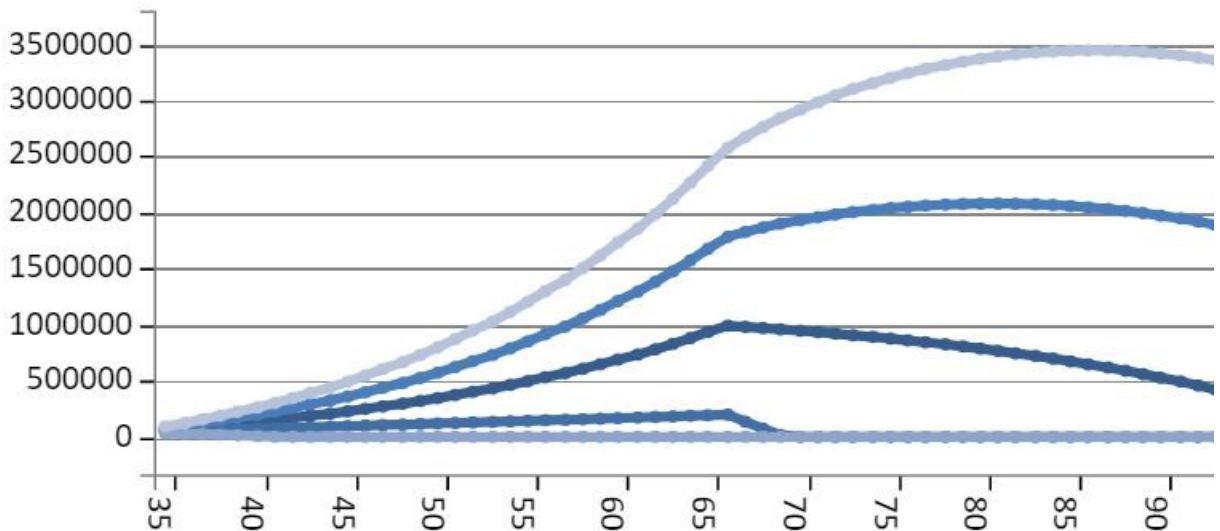
Below is the plot of different possible portfolio values with 1% volatility. 90-day T-Bills have a volatility of around 1%.



Next is the plot of different possible portfolio values with 10% volatility. A diversified portfolio of stocks and bonds has a volatility of around 10%.



Here is the plot of different possible portfolio values with 30% volatility. Individual stocks can have volatilities of around 30% or even higher.



The mean value of all these plots show a portfolio value close to one million dollars at retirement. However, the possible portfolio values vary dramatically as the volatility increases. The income stream the portfolios generate in retirement become less and less dependable with increasing volatility until there is little confidence that they can be relied on.

In order to be confident in your retirement plan you need to have confidence in both the expected return as well as the expected volatility.

Part 1: Return And Volatility

The Relationship Between Return And Volatility (Or Risk)

In general, there is a correlation between increasing risk and increasing return. In order to get a higher annualized return, you will generally get higher annualized volatility, or risk, as well.

Below is the annualized real return and annualized volatility for various assets for the time period shown. Real return subtracts inflation from the annual return to better represent the underlying asset's actual return. It also allows for better comparison between periods of time with different levels of inflation.

From 12/31/71 through 2/28/17

Description	Asset/Index	Annualized Real Return	Annualized Volatility	Notes
Money Market	90-day T-Bill	0.87%	1.00%	
Ultra Short Term Bond	1-yr Treasury	1.51%	1.86%	
Short Term Bond	3-yr Treasury	2.16%	3.12%	
International Stocks	MSCI EAFE	2.33%	17.12%	
Commodities	S&P GSCI	2.46%	20.32%	
Intermediate Term Bond	10-yr Treasury	3.36%	7.12%	
Precious Metals	Gold	3.69%	21.29%	
Real Estate	FTSE NAREIT	5.71%	17.59%	
Financial Stocks	MSCI Financial	6.21%	19.17%	
Domestic Stocks	S&P 500 Total Return	6.43%	15.16%	
10 S&P 500 Stock Portfolio		6.43%	18.74%	Estimated Return and Volatility
Single S&P 500 Stock Portfolio		6.43%	37.40%	Estimated Return and Volatility
Consumer Discretionary Stocks	MSCI Consumer Discretionary	6.58%	20.99%	
Consumer Staple Stocks	MSCI Consumer Staples	8.37%	16.19%	
Technology Stocks	MSCI Technology	8.78%	26.78%	
Industrial Stocks	MSCI Industrial	8.82%	18.94%	
Healthcare Stocks	MSCI Healthcare	9.87%	20.34%	
ProFolio Tactical Capital Preservation Portfolio		3.18%	4.05%	Simulated Results, See Disclosure
ProFolio Strategic Multi-Asset Portfolio		4.97%	9.16%	Simulated Results, See Disclosure
ProFolio Tactical Multi-Sector Portfolio		10.42%	16.61%	Simulated Results, See Disclosure
ProFolio Tactical Multi-Asset Portfolio		10.71%	11.59%	Simulated Results, See Disclosure

From 12/31/96 through 2/28/17

Description	Asset/Index	Annualized Real Return	Annualized Volatility	Notes
International Stocks	MSCI EAFE	-0.19%	16.86%	
Money Market	90-day T-Bill	-0.04%	0.61%	
Emerging Market Stocks	MSCI Emerging Market	1.25%	23.71%	
Mortgage Backed Securities	S&P GNMA	3.03%	2.82%	
Intermediate Term Bond	10-yr Treasury	3.49%	6.36%	
Global Bonds	Barclay Global Aggregate	3.68%	6.78%	
Domestic Stocks	S&P 500 Total Return	5.75%	15.21%	
Emerging Market Bonds	JP Morgan EMBI	6.51%	9.97%	Estimated Return and Volatility
High Dividend Yield	FTSE HDY	6.64%	13.23%	Estimated Return and Volatility
Real Estate	FTSE NAREIT	6.99%	19.68%	
ProFolio Tactical Income Portfolio		6.80%	6.67%	Simulated Results, See Disclosure
ProFolio Tactical Balanced Portfolio		7.66%	9.30%	Simulated Results, See Disclosure

Part 2: Portfolio Probabilities

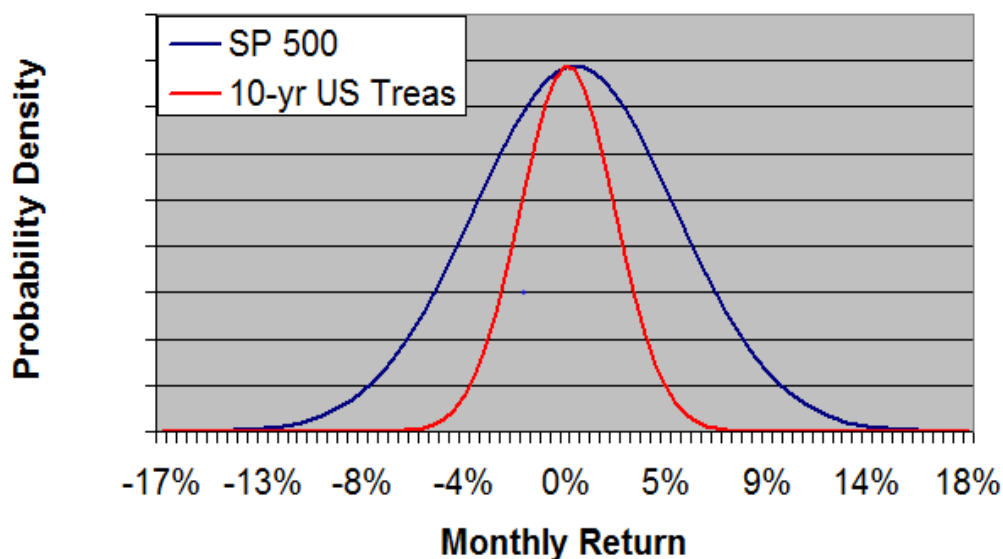
The Normal Distribution

The random variation of monthly or annual asset returns conform to a probability distribution known as the normal (Gaussian) distribution or bell curve. The probability distribution for the asset is described by its average return, or mean, and its volatility, or standard deviation.

Standard deviation is the square root of the average of the squared deviations from their average value and is a measure of the dispersion of the data. A low standard deviation means the data is close to the average while a high standard deviation means the data is spread across a wide range of values.

For example, the plot below shows the probability distributions for both the S&P 500 total return and the 10-year US Treasury from 12/31/71 through 1/31/17.

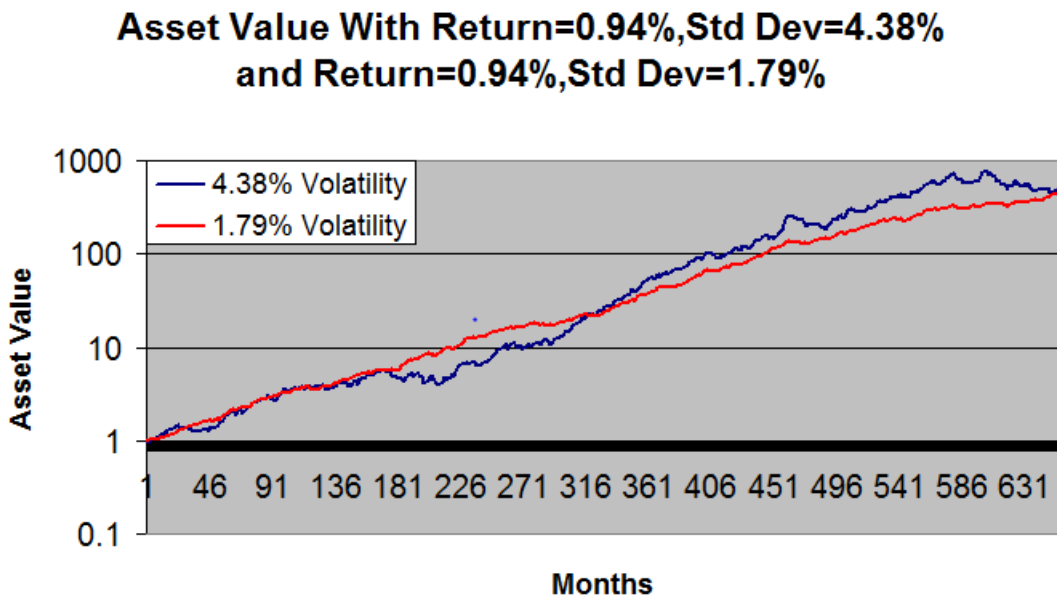
Stock/Bond Probability Distribution



The average monthly return for the S&P500 during this time period was 0.94% with a monthly standard deviation of 4.38%. The 10-year US Treasury had an average monthly return of 0.62% with a monthly standard deviation of 2.06%. Clearly the bonds have lower dispersion or volatility than the stocks, but also a lower average return.

Asset Values With Higher And Lower Volatility

Assets with a lower standard deviation, or volatility, have less variation in their return than assets with higher volatility. Below is a plot of the asset values over time of two assets with equal return and different volatility. The asset with lower volatility has less variability in performance.



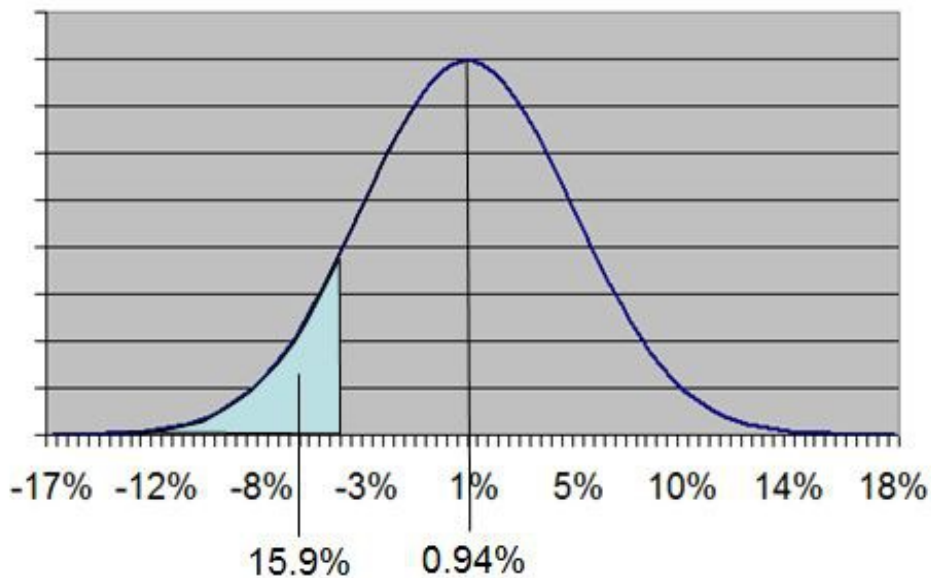
Probabilities For Normally Distributed Assets

For an investment portfolio, we care about the probability the portfolio is above or below a desired value.

For the S&P 500, which is normally distributed, there is a 15.9% probability the monthly return will be lower than -3.4% (which is 0.94% - 4.38%, or one standard deviation below the mean). There also would be a 2.3% probability the monthly return would be lower than -7.8% (which is 0.94% - 2*(4.38%), or two standard deviations below the mean).

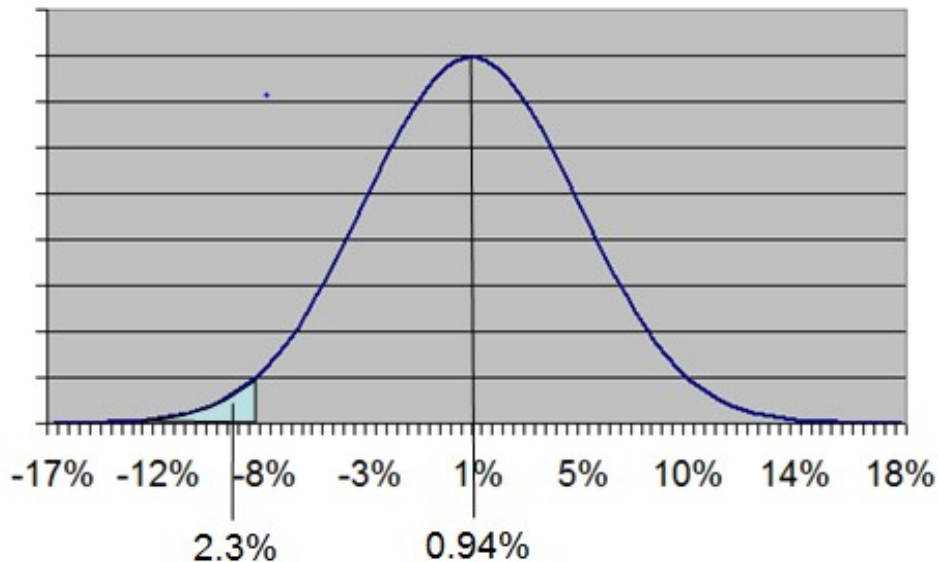
S&P 500 Probability Distribution

Monthly Returns (Mean Return = 0.94%)



S&P 500 Probability Distribution

Monthly Returns (Mean Return = 0.94%)



The Accumulation Of Risk and Return

Using the monthly return and standard deviation, of the S&P 500, 0.94% and 4.38% respectively, since monthly return is not random, the expected return after 12 months is $(1.0094)^{12}$, or 11.88%. The variability in the monthly data is random and therefore the volatility, or standard deviation, accumulates as the square root of the sum of squares. The annual standard deviation is $\text{SQRT}(12)$ times the monthly standard deviation or 15.17%.

The expected return after 30 years is $(1.0094)^{360}$ or 2802.61%. The standard deviation after 30 years is $\text{SQRT}(360) \times 4.38\%$ or 83.1%. Since the returns follow a normal distribution, the probability of the actual return being one standard deviation below the expected return ($2802.61\% - 83.10\% = 2719.51\%$) is 15.9%. The probability of being two standard deviations below the expected return ($2802.61\% - 2 \times 83.10\% = 2636.41\%$) is 2.3%.

Portfolio Value Plots

The portfolio value plots show the accumulation of both risk and return in the investment account.

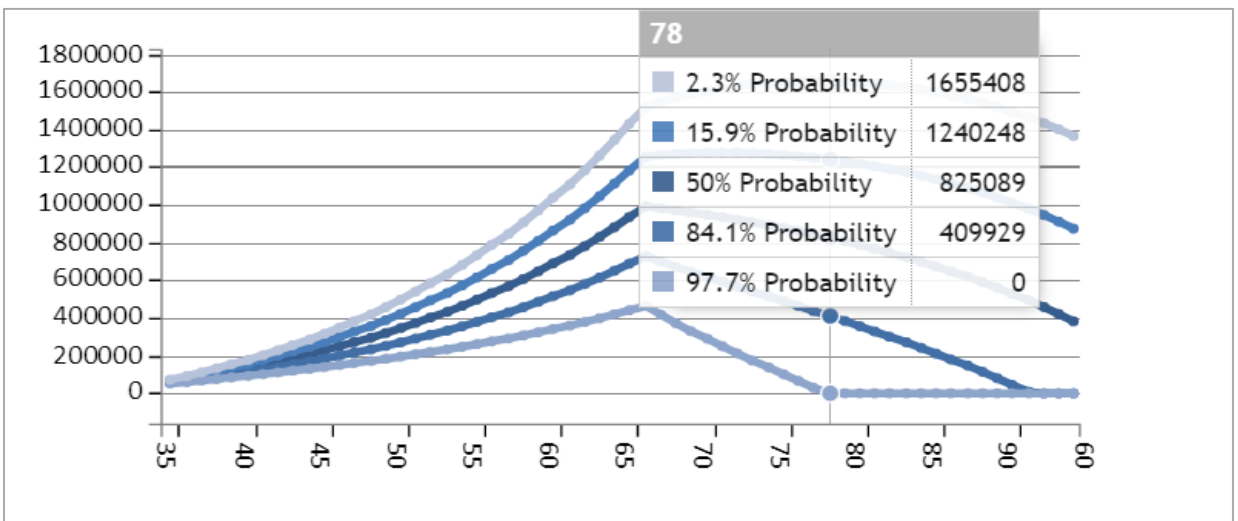
The bottom line on the graph below shows two standard deviations below the mean return. The probability of the portfolio being above this value is 97.7%. This line hits zero at age 78, therefore the probability of not running out of money through age 78 is 97.7%.

The second line from the bottom shows one standard deviation below the mean. The probability of the portfolio being above this value is 84.1%. The portfolio has a 84.1% probability of having money through age 90.

The third line up from the bottom, or middle line, shows the mean return. The probability of the portfolio being above this value is 50%. The mean value of the portfolio at age 78 is \$825K.

The fourth line from the bottom shows one standard deviation above the mean. The probability of the portfolio being above this value is 15.9%.

The top line on the graph shows two standard deviations above the mean return. The probability of the portfolio being above this value is 2.3%.



Part 3: Disclosure

The information presented here is the opinion of the author and may quickly become outdated and is subject to change without notice. All material presented in this document are compiled from sources believed to be reliable, however accuracy cannot be guaranteed. No person should make an investment decision in reliance on the information presented in here.

The ProFolio model portfolio results presented here are based on simulated or hypothetical performance. Unlike an actual performance record, simulated results do not represent actual trading and there is no market risk involved in the results. The simulated trades use historical data and therefore the trading algorithms are designed with the benefit of hindsight. In a simulated performance record it may be difficult, if not impossible, to account for all factors which might affect an actual performance record. Additionally, any account that ProFolio manages will invest during periods with different economic conditions than those under which the trading programs were developed. There is no representation being made that any account will perform as the hypothetical results indicate. In fact, there are often sharp differences between hypothetical results and actual returns subsequently achieved. Due to the benefit of hindsight, hypothetical performance almost invariably will show attractive returns, while actual results going forward may not be as attractive. As with all market investments, client investments can appreciate or depreciate.

The algorithm that created the trading signals for each of the portfolios used Exchange Traded Fund (ETF) historical data where possible. This ETF data had a limited history. To gain additional data history, the actual asset or index data was pre-pended to the ETF data. When this occurred, ETF expenses were subtracted from the asset or index data. Where asset or index data was not available, other correlated data, adjusted for expenses, was used. Model portfolio results include interest

and dividends, but subtract ProFolio's management fee (0.5%) and third-party brokerage custody/trading fee (0.25%). Real return is inflation adjusted. Higher returns generally come with higher risks. Model portfolio risk characteristics include maximum drawdown and volatility. Maximum drawdown is the portfolio's peak to trough prior to hitting a new peak and is a measure of downside risk. Volatility, or standard deviation, is a measure of the portfolio's price fluctuations both positive and negative. Sharpe ratio is a measure of return for a given risk. Sharpe ratio = $(\text{portfolio return} - \text{risk free return}) / \text{SQRT}(\text{portfolio return variance} - \text{risk free return variance})$. Where the risk free asset is the 90-day T-bill and the variance is the square of the standard deviation (or volatility). Tactical portfolios utilize cash or cash equivalents for risk management.

The information presented here is distributed for education purposes only and is not an offer to buy or sell or a solicitation of an offer to buy or sell any security or participate in any particular trading strategy.