

Introduction

This article uses the *Quantext Portfolio Planner*, a Monte Carlo portfolio management tool, to examine asset allocation effectiveness of a portfolio of ETF's and to propose modifications that can substantially improve portfolio performance. Most people, if they have heard about Monte Carlo at all, are only aware of its use in determining how much income you can safely draw from a portfolio in retirement. This is only a part of the value of Monte Carlo models. These models are also very useful in determining the right asset allocation throughout your working life. Links to some educational resources on Monte Carlo portfolio planning tools are given at the end of this paper.

I am a fan of David Jackson's *Radical Guide to Investing* website, so taking the basic ETF portfolio that is proposed on his site seemed like a good place to start—for a link see the Online Resources section at the end of this paper. The *Radical Guide* ETF portfolio looks pretty reasonable (see below), with a concentration in a total market index (IVV), and a range of other ETF's, including small cap, medium cap, emerging markets, bonds, and real estate. Is this a portfolio that makes sense?

ETF Ticker	Expense Ratio	Equivalent Vanguard Fund	Sample Asset Allocation
IVV	0.09%	Vanguard 500 Index Fund Investor Shares (VFINX)	35%
IJH	0.20%	Vanguard Mid-Cap Index Fund Investor Shares (VIMSX)	10%
IWM	0.20%	Vanguard Small-Cap Index Fund Investor Shares (NAESX)	5%
EFA	0.35%	Vanguard Developed Markets Index Fund (VDMIX) (tracks MSCI EAFE)	20%
EEM	0.75%	Vanguard Emerging Markets Stock Index Fund (VEIEX)	5%
SHY	0.15%	Vanguard Short-Term Bond Index Fund Investor Shares (VBISX)	10%
IEF	0.15%	Vanguard Intermediate-Term Bond Index Fund Investor Shares (VBIX)	5%
TLT	0.15%	Vanguard Long-Term Bond Index Fund (VBLTX)	5%
RWR	0.25%	Vanguard REIT Index Fund Investor Shares (VGSIX)	5%

Figure 1: The Radical Guide ETF Portfolio

We entered this portfolio into Quantext Portfolio Planner and ran an analysis using market data for the last three years, and account for ETF fees. ETF's are fairly new, so trying to use substantially longer horizons is impossible. In fact, we had to replace EEM with its closest Vanguard fund equivalent, VEIEX, because of limited data history for EEM. The Quantext Portfolio Planner takes historical data for each ETF, calculates basic statistics for each ETF, accounting for the correlation between ETF's and the market as a whole. QPP then runs a forward-looking Monte Carlo simulation on the portfolio.

The Radical Guide ETF Portfolio

The basic features of the resulting portfolio (shown below) are quite interesting.

			Portfolio Stats	
Fund Name	Percentage of Funds	Average Annual Return	Average Annual Return	Standard Deviation (Annual)
IVV	35.0%	8.33%	9.08%	13.60%
IJH	10.0%	10.34%		
IWM	5.0%	13.69%		
EFA	20.0%	10.41%	Historical Data	
VEIEX	5.0%	13.72%	Start: 12/1/2002	End: 12/1/2005
SHY	10.0%	1.96%	Average Annual Return	Standard Deviation (Annual)
IEF	5.0%	6.48%	15.84%	8.40%
TLT	5.0%	10.03%	Historical Beta: 85.07%	
RWR	5.0%	13.67%	Performance of S&P500 over historical period	
-	0.0%	8.30%	Average Annual Return on S&P500	
-	0.0%	8.30%	12.55%	
-	0.0%	8.30%	Annual Standard Deviation on S&P500	
-	0.0%	8.30%	9.10%	
-	0.0%	8.30%		
-	0.0%	8.30%		
-	0.0%	8.30%		
-	0.0%	8.30%		
-	0.0%	8.30%		
Sums to	100.0%			
			Market Index (S&P500)	
Simulated Portfolio Beta 87.50%			Average Annual Return	Standard Deviation (Annual)
			8.30%	15.07%

Figure 2: Monte Carlo Output for Radical Guide ETF Portfolio

For our forward looking projection, we are quite conservative. We assume an average return on the S&P500 of 8.3% per year and a standard deviation of 15.07% per year. These are reasonable assumptions, based upon historical market volatility and economists' projections. With these inputs, the Radical Guide model ETF portfolio is projected to generate 9.08% per year, with a standard deviation of 13.6% per year. The vertical column that shows Average Annual Return for each ETF gives projected values for each ETF. The model ETF portfolio is projected to generate about 0.8% per year more than the market as a whole with less total risk, even though this portfolio has outperformed the market as a whole by more than 3% per year over the past three years(*Historical Data* table above). This is nice, but the Monte Carlo model projects that the expected return is not going to outpace the S&P500 at such a high level. This is one of the primary sources of value for Monte Carlo vs. simply looking at recent history. The Monte Carlo model can account for the fact that recent strong performance relative to risk is not likely to be sustained for the long haul. Still, while the Monte Carlo projection says that this portfolio will generate 0.8% per year more than the S&P500 with less risk, it's not a bad portfolio.

Radical Guide Portfolio with Re-Allocation

Can we build a better portfolio by simply changing the allocation between these ETF's? Having run the Monte Carlo already for these ETF's, it is very easy to experiment with the allocations to find a portfolio in which the pieces work together in a more synergetic way. The key to strategic portfolio allocation is to manage total volatility and Beta together. When we do this, we can find a portfolio that provides the maximum return for the total portfolio risk. After a bit of playing around with this list of ETF's, we found a better looking allocation (below). This new portfolio has historically shown less risk (measured by standard deviation), lower Beta, and a return that is 2% per year greater than the initial allocation. This improved portfolio is projected to generate 10.19% per year, a little more than 1% per year more than the original allocation.

			Portfolio Stats	
Fund Name	Percentage of Funds	Average Annual Return	Average Annual Return	Standard Deviation (Annual)
IVV	8.0%	8.33%	10.19%	13.46%
IJH	10.0%	10.34%		
IWM	10.0%	13.69%		
EFA	20.0%	10.41%	Historical Data	
VEIEX	10.0%	13.72%	Start:	End:
SHY	10.0%	1.96%	12/1/2002	12/1/2005
IEF	7.0%	6.48%	Average Annual Return	Standard Deviation (Annual)
TLT	10.0%	10.03%	17.67%	8.66%
RWR	15.0%	13.67%	Historical Beta: 79.62%	
-	0.0%	8.30%	Performance of S&P500 over historical period	
-	0.0%	8.30%	Average Annual Return on S&P500	
-	0.0%	8.30%	12.55%	
-	0.0%	8.30%	Annual Standard Deviation on S&P500	
-	0.0%	8.30%	9.10%	
-	0.0%	8.30%		
-	0.0%	8.30%		
-	0.0%	8.30%		
Sums to	100.0%		Market Index (S&P500)	
			Average Annual Return	Standard Deviation (Annual)
			8.30%	15.07%
			Simulated Portfolio Beta	
			81.89%	

Figure 3: Improved Allocation of *Radical Guide* ETF Portfolio Components

New Portfolio Components Added

We can actually now do even better if we add some more ETF's to the mix. While the selection provided for the *Radical Guide* is not too bad, it is also not optimal. What makes it less than optimal is that there are not enough low-Beta stock ETF's. Raw materials and energy tend to be low Beta, for example. When we add a few more ETF's to the mix, we can build a more attractive portfolio both from a historical perspective and in looking to the future (see below).

			Portfolio Stats	
Fund Name	Percentage of Funds	Average Annual Return	Average Annual Return	Standard Deviation (Annual)
IVV	5.0%	8.33%	11.04%	11.73%
IJH	5.0%	10.34%		
IWM	10.0%	13.69%		
EFA	10.0%	10.41%	Historical Data	
VEIEX	0.0%	13.72%	Start:	End:
SHY	0.0%	1.96%	12/1/2002	12/1/2005
IEF	15.0%	6.48%	Average Annual Return	Standard Deviation (Annual)
TLT	15.0%	10.03%	17.68%	8.54%
RWR	10.0%	13.67%	Historical Beta: 64.67%	
IDU	10.0%	10.17%	Performance of S&P500 over historical period	
IXC	10.0%	14.32%	Average Annual Return on S&P500	
IGE	10.0%	14.37%	12.55%	
-	0.0%	8.30%	Annual Standard Deviation on S&P500	
-	0.0%	8.30%	9.10%	
-	0.0%	8.30%		
-	0.0%	8.30%		
-	0.0%	8.30%		
-	0.0%	8.30%		
-	0.0%	8.30%		
Sums to	100.0%			
Simulated Portfolio Beta 66.52%			Market Index (S&P500)	
			Average Annual Return	Standard Deviation (Annual)
			8.30%	15.07%

Figure 4: Final modified portfolio with additional ETF choices

The three additional choices that we added are all iShares ETF's—largely because this is an ETF family that I have been analyzing lately. These ETF's are IDU (U.S. utilities ETF), IXC (global energy ETF), and IGE (natural resources ETF). These three have higher fees than those in the original group, but their portfolio effects more than compensate. The historical performance for this portfolio is about the same as the previous case, but the projected future return is higher (11.04% per year), the projected standard deviation is considerably lower (11.73%) and the historical and projected Beta is around 65%, much lower than the previous portfolio which had a Beta of around 80%.

So, let's think about how all of these pieces fit together. I agree with the Radical Guide's basic proposition that most investors would be better off with a strategic allocation into a group of ETF's. The ETF's that are in this portfolio are pretty reasonable but the portfolio lacks a few optimal pieces. First, the allocation can be tuned so that the projected and historical volatility (measured by Standard Deviation) is a lower, the projected and historical return is higher, and the Beta on the portfolio is lower. All of these are desirable traits. The main thing that is gained in the re-allocated portfolio is a gain is 1.1% per year in average return (on a projected basis) for a portfolio with a lower Beta. On an historical basis, the re-allocated portfolio actually outperformed by 2% per year, but our forward-view discounts some of this as due to chance. This portfolio did not gain higher returns by increasing risk---its just better allocation to take advantage of portfolio effects. The lower Beta in the re-allocated portfolio (76% vs. 85%) means that you are less exposed to market volatility.

When we add a couple of powerful 'diversifiers' to our portfolio to create a bigger set of possible investments, the portfolio improves further still. We now have a portfolio with a projected annual return that is almost 2% per year greater than the original portfolio, with substantially less volatility (measured by Standard Deviation) on a forward-looking basis than the original portfolio. Now, what does this means to us? The combination of an improvement in projected average return and a reduction in standard deviation is dramatic when you look at a long-term horizon.

The Impact of Strategic Portfolio Allocation

One of the most common and relevant ways to assess the overall risk and return associated with a portfolio using a Monte Carlo model is to look at portfolio survival rates. The portfolio survival rate is the probability that your portfolio will run out of money in retirement by a certain age, given a specified income draw. This will become clearer as we proceed. Consider our John Doe:

Current Age	40
Date of Retirement	2030
Age at Retirement	65
Annual Contribution (2005 Dollars)	\$20,000
Current Portfolio Value	\$160,000
Inflate Contributions at inflation?	Yes
Inflate Income Draw?	Yes
Income in Retirement (2005 Dollars)	\$100,000

Figure 5: John Doe's Profile

John Doe is 40 years old and plans to retire at age 65. He is socking away \$20K per year into his retirement (say a 401(k) with company match) and he currently has \$160K in his portfolio. His plan is to draw \$100K per year in 2005 dollars, which means that his draw will increase with inflation. He also escalates his savings with inflation. We have assumed an inflation rate of 3%. If we assume that John Doe invests in the model ETF portfolio from Radical Guide, and project forward with our Monte Carlo model, how do things look for him?

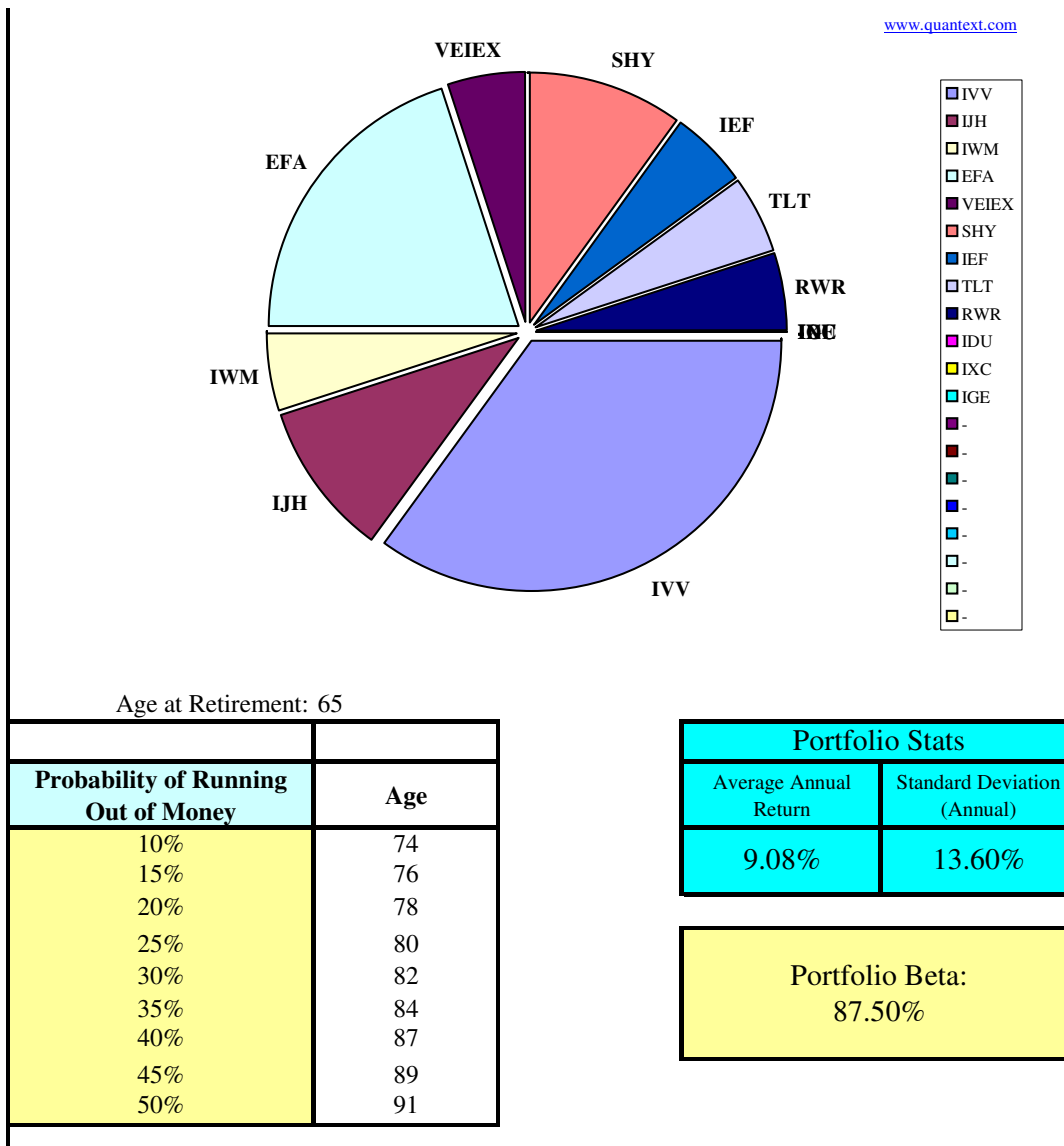


Figure 6: Radical Guide portfolio survival rates for John Doe

The chart above comes directly from the portfolio planner’s reports. Using the Radical Guide Portfolio shown earlier, we calculate that John has a 20% chance of running out of money by age 78 (see above). Wow—that is not good. Note that this probability of running out of money is a function of income draw, inflation, average return, and the standard deviation in return. Risk (measured by standard deviation) has a big impact.

Now, if we look at the same output for John Doe’s future using our final modified portfolio—the one using the three new ETF’s—we have a very different outcome:

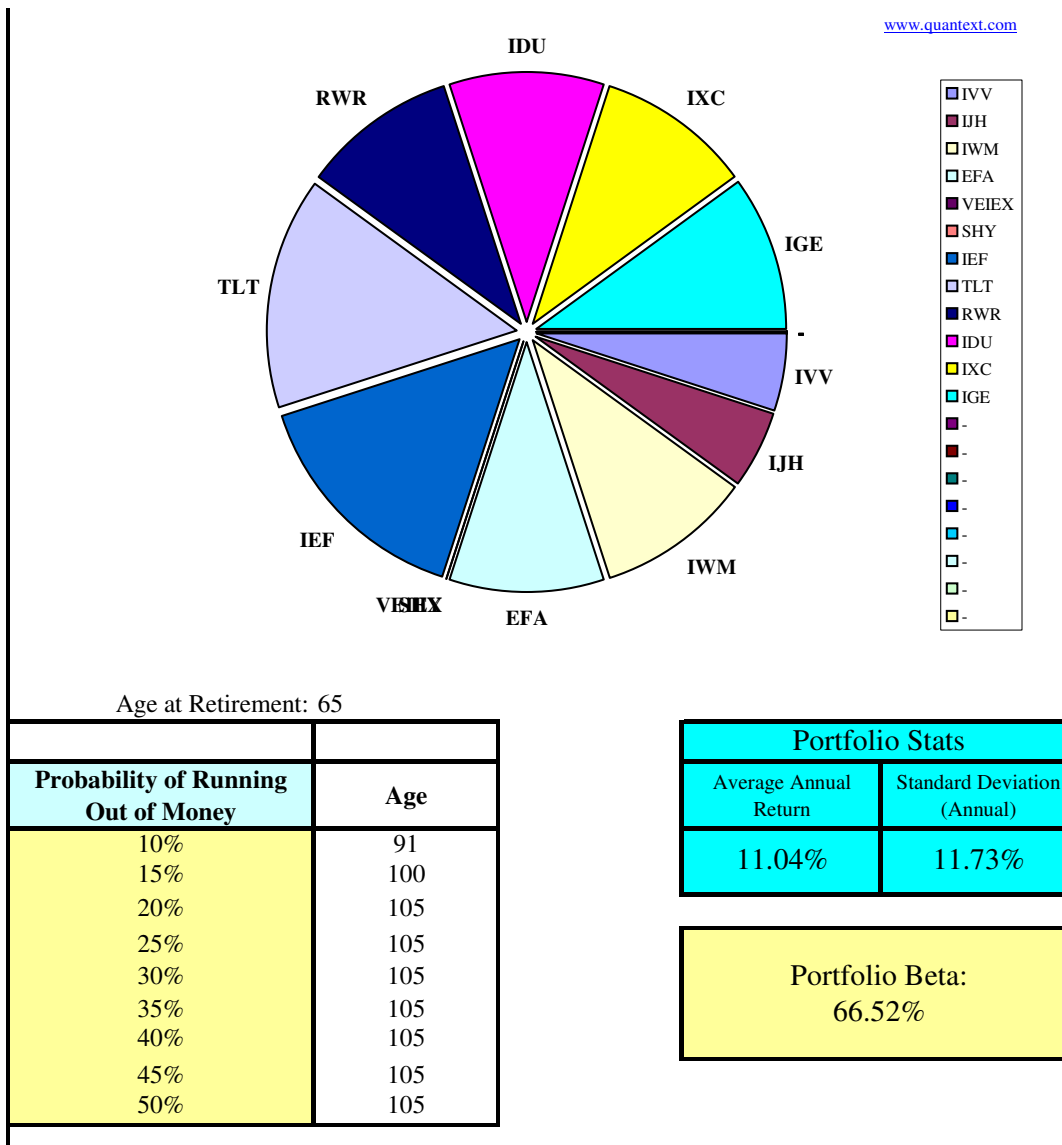


Figure 7: Portfolio survival with the final modified portfolio

Now, John Doe has a projected probability of running short of funds that looks far more attractive. He has a 20% chance of running out of funds by age 105 and only a 10% chance of running out of funds by age 91 (See Figure 7).

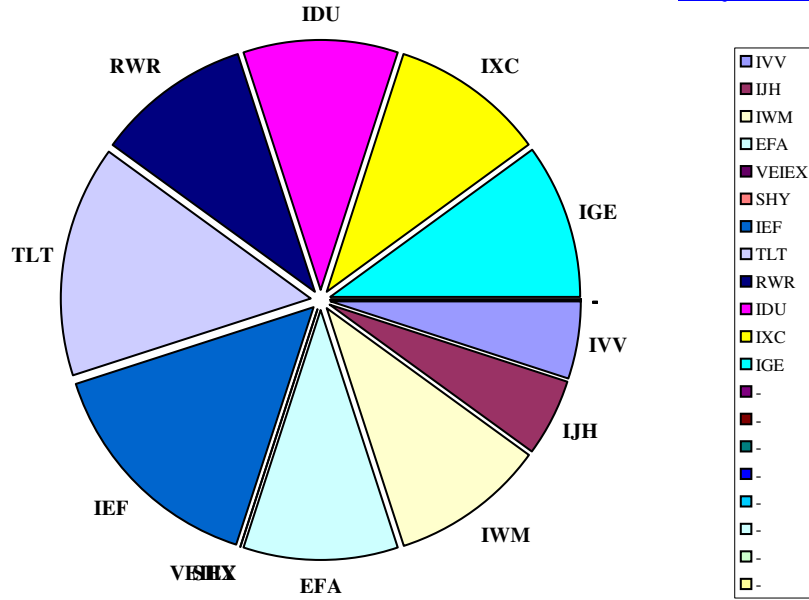
Now, if you look back at our analysis of the portfolio components in the final modified portfolio (Figure 4), you might take issue with the fact that the projected average annual returns for these three energy and natural resource ETF's are so high. Personally, I think

that given the growth in world demand for energy and natural resources, these projections are reasonable but this is certainly open for debate. So, as a sanity check we have reduced the estimated annual returns for each of these added ETF's by 5% per year:

IDU	10.0%	5.17%
IXC	10.0%	9.32%
IGE	10.0%	9.37%

Figure 8: The 3 new ETF's with a 5% reduction in average annual return for each (compare to Figure 4).

If we look at the Monte Carlo results now (Figure 9), the average annual return is lower but the portfolio standard deviation is the same. This makes sense. The projected portfolio now suggests that John Doe has a 20% chance of running out of funds by age 83. That's a lot less attractive than our final modified portfolio, but it is still five years better than the original Radical Guide portfolio! Where does the five years of extra retirement come from? The average return on this portfolio with strongly reduced projected returns for these three ETF's is only about 0.5% better than that from the Radical Guide portfolio. Much of the improvement in performance is due to the reduction in the total volatility of the portfolio, as measured by the annual standard deviation in return.



Age at Retirement: 65

Probability of Running Out of Money	Age
10%	78
15%	81
20%	83
25%	86
30%	91
35%	94
40%	97
45%	100
50%	105

Portfolio Stats	
Average Annual Return	Standard Deviation (Annual)
9.54%	11.73%

Portfolio Beta: 66.52%

Figure 9: Final modified portfolio with a 5% reduction in expected return for the three added ETF's

Wrapping It Up

There is abundant statistical evidence that most of the variability in the returns on mutual funds are due to asset allocation rather than individual stock selection. An individual investor will do far better to focus on a proper strategic allocation of his or her portfolio than upon trying to find the next hot stock. The Vanguard study in the Online Resources section at the end of this paper presents a recent study and the history of these analyses.

Many investors in mutual funds end up doing far worse than the average index fund due to attempting to time the market or simply engaging in buying and selling behavior that racks up taxes and fees with no appreciable gains. The best that most investors will be able to do is to invest in a strategically allocated portfolio of low-cost ETF's. This paper has looked at how much difference strategic allocation can make, starting with a common-sense portfolio proposed by the *Radical Guide to Investing*.

There is no question that there is uncertainty in future expected return and volatility on the market as a whole and for individual sectors. A good Monte Carlo allows the user to examine reasonable projections for future returns, given uncertainty in market behavior and in the performance of individual stocks and sectors relative to the market. This is the best way to estimate the total portfolio risk and return of a portfolio and will typically yield results very different from simply looking at historical performance. In particular, a Monte Carlo model should temper recent market performance in favor of a longer-term balance between risk and return.

When we run a reasonably diversified portfolio of ETF's through the Quantext Portfolio Planner Monte Carlo model, we can generate reasonable projections of future performance and risk that allow the user to estimate short-term and long-term potential losses, as well as the level of income that a portfolio is likely to support. *The Radical Guide's* proposed ETF portfolio looks pretty good when we run it through the portfolio planner. The real value of using the Monte Carlo model to examine portfolio allocation in this case is that we can 'tune' the portfolio to take more advantage of diversification effects among various ETF's, with the final result of a portfolio that has both substantially outperformed the original portfolio during the most recent three years but is also projected to substantially out-perform over the future. These results have been made based on the assumption that the future long-term volatility in the market as a whole will be considerably higher than we have seen in the past several years—reverting back to levels more similar to history. While most investors will say that the past several years have been anything but 'calm' in the market as a whole, the volatility of the S&P500 over

the past several years has been well below long-term historical levels. Don't believe me? Check it for yourself by looking at SPY (an S&P500 ETF):

<http://finance.yahoo.com/q/rk?s=SPY>

The annual standard deviation for SPY over the past three years has been about 10%, while the annual standard deviation over the past five years has been about 15%, which is close to what we assume for the long-term for the S&P500 and is consistent with the long-term performance of the market as a whole. These results show that the past three years have had market volatility that is 1/3 less than the long-term average. In planning, it makes more sense to consider the impacts of risk levels closer to long-term history unless you have some reason to assume that the future stock market will exhibit substantially lower volatility.

The final ETF portfolio that we develop using the Quantext Portfolio Planner has lower historical volatility, higher historical return, lower Beta, and higher projected future return with lower risk. From my perspective, this final portfolio looks like a better choice and I don't see any downside. Further, when we consider the impact of the final tuned portfolio on the survival rates of the portfolio in supporting future income, even a conservative estimate suggests that the final portfolio adds 5+ years to the retirement that can be supported.

Online Resources

Quantext Portfolio Planner / Retirement Planner:

www.quantext.com

Resources for learning about Monte Carlo tools for portfolio planning

<http://www.quantext.com/subpage.html>

Radical Guide to Investing:

http://www.radicalguides.com/2005/06/the_radical_gui.html

Radical Guide to Investing ETF portfolio

http://www.radicalguides.com/2005/06/radical_guide_t_38.html

Vanguard study on asset allocation vs. stock picking or timing:

https://institutional5.vanguard.com/iip/pdf/icr_asset_allocation.pdf