Managing Downside Risk in Retirement Planning

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The bear market of 2007-2008 caused widespread concern among investors about the long-term downside potential of equities in retirement planning. Investors who were largely or completely invested in equities were painfully exposed.

That need not have been the case. Boston University professor Zvi Bodie has advocated a strategy that offers investors some of the upside potential in equities tempered with downside protection against bear markets and a low-risk inflation hedge via heavy allocation to TIPS. While I expect few adopted Bodie's strategy, those who did likely remain well-positioned to reach their retirement goals.

Since its introduction in 1995, Bodie's strategy has not gained much popularity or acceptance. Its merits, however, became clear during the recent bear market, a textbook example of something Bodie warned about in his paper: While the probability of stocks under-performing bonds declines with holding period, the severity of the worst-case downside scenario actually increases with time.

In a recent article, I reviewed Bodie's arguments and showed how Monte Carlo simulations reinforce his point. Because of the potential for severe losses relative to inflation-protected bonds (TIPS), even over long time horizons, Bodie proposed in a 2001 paper that investors should have the majority of their holdings in TIPS. They should invest a smaller fraction in call options on the S&P500, he argued. The high allocation to TIPS provides the security of government bonds, along with inflation protection so that an investor can protect his or her purchasing power.

Bodie called his strategy the 90/10 strategy: 90% of holdings go into TIPS and 10% go into call options on an equity index. The idea is conceptually simple, but it is sufficiently different from the common practice of most investors (and advisors) that his approach is not well understood or widely applied. Monte Carlo simulations explain and demonstrate the value of Bodie's 90/10 approach.

The obvious appeal of Bodie's 90/10 strategy is that there is an absolute floor on portfolio losses that a decline in equities can cause, even in the worst market conditions. (This does not, however, mean that the portfolio cannot lose more than 10% of its value.)

It is possible that the lack of popularity of Bodie's approach is due to its reliance on TIPS, but the effectiveness of the strategy in creating a floor for the portfolio does not

require that all bonds in the portfolio be TIPS. Investors and advisors can use a mix of nominal and inflation-protected bonds in the fixed income portion. The option portion of the portfolio gives investors some of the upside of equities if the markets rise. Using options to gain equity exposure, rather than simply buying an index fund, gives the investor exposure to almost as much of a bull market's upside as a portfolio of equities would.

Many advisors and investors do not understand options or how they really work, and that too may be inhibiting the wide adoption of Bodie's approach. The leverage afforded by options is a key component — but understanding this requires that investors understand options and how they work. For those with a good grasp on options, Bodie's 90/10 strategy and its variants can be a very important addition to the suite of portfolio management strategies.

Baseline 90/10 Portfolio

One of the challenges for the 90/10 strategy is to make the approach really concrete, so let's start with an example that uses real numbers. I have created a Monte Carlo analysis of the 90/10 portfolio that has been adjusted so that its projected market volatility is consistent with long-dated options on SPY. Long-dated options on SPY provide an estimate of the market's expectation of future volatility. By making sure that the Monte Carlo model generates a similar level of volatility for the S&P500, we have a sanity check for the performance of this strategy.

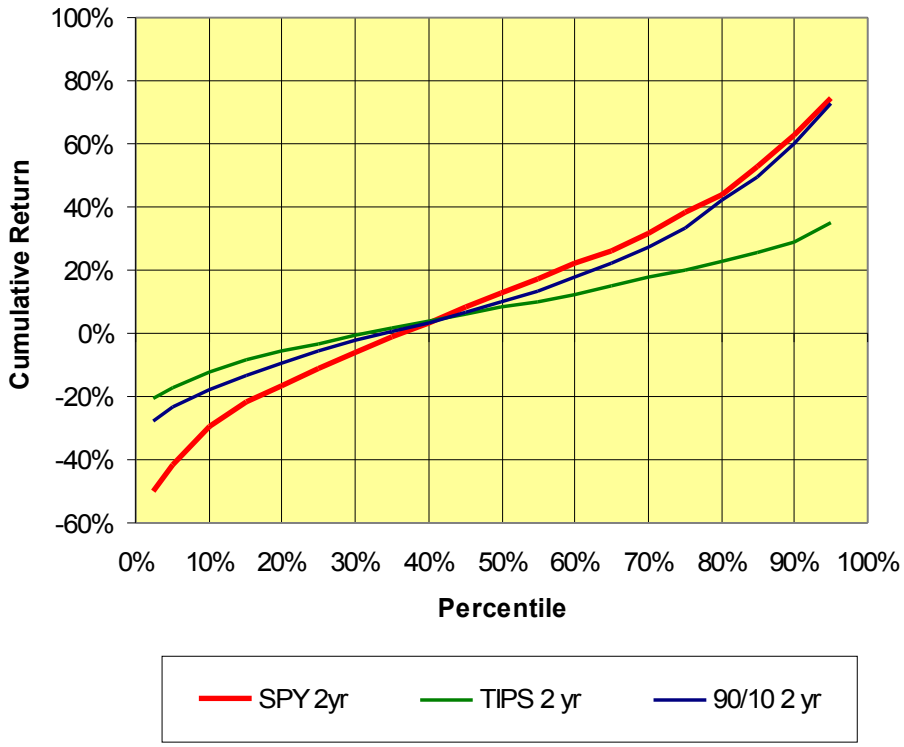
I ran the Monte Carlo analysis using the trailing three years of market data to account for the higher correlations between asset classes that have been observed. I also adjusted the performance of equities to a fairly conservative level, consistent with the best available estimates of the future equity risk premium (see here).

I assumed that the options portion of the portfolio is invested with strikes at-the-market (meaning that the strike prices of the call options are right around the price of the underlying index fund) and with a two-year expiration horizon. I have ensured that the options premiums are consistent with what similar options are selling for today. A call option on SPY with a strike price of $110 expiring in December of 2011 has 2.2 years until expiration. As of this writing, this option costs $13.90 and SPY is at $109. When I price this option using the Monte Carlo simulation, the simulated fair price is $13.80. The simulated volatility (risk) and the prices of options are consistent with market levels. This is obviously an important check if one is considering pursuing this strategy.

The Monte Carlo analysis accounts for the current dividend yield of the market, which affects the attractiveness owning options for your equity market exposure because the owner of a call option does not receive dividends.

How much leverage one can achieve depends on the prices of options, which in turn depend on the dividend yield and (more importantly) the volatility of the market. The long-term implied volatility of options on SPY is about 25% (see here) — considerably higher than the long-term average realized level of market volatility, which is around 15%-20%. The higher implied volatility raises prices for options and thereby reduces how many options you can buy with the 10% of the portfolio to be allocated to options. In the current market, you can buy 9.3 two-year at-the-money call options for the cost of one share of SPY. This is what provides the leverage. This leverage ratio will vary with time, but is easily calculated.

The simulated 90/10 portfolio has 90% in TIPS and 10% in the two-year at-the-money call options on SPY. Let's look at the projected range of performance of this portfolio relative to the S&P500 and relative to TIPS.



Basic 90/10 Outcomes with 90% in TIPS and 10% in call options on SPY

The chart above shows the two-year projected cumulative returns for three portfolios:

1) 100% invested in the S&P 500 (SPY)
2) 100% invested in TIPS (TIP)
3) 90% invested in TIP and 10% invested in the at-the-money call options (90/10)

The horizontal axis shows the probability that the portfolio will generate at or below the corresponding level of return found on the vertical axis. The vertical axis shows the cumulative return projected for a two-year period. At the far left of this chart, we can see the worst 2.5% of outcomes — the kind of extreme event that happens once in 40 years. For the S&P 500 (SPY), the Monte Carlo Simulation (MCS) estimates a cumulative two-year loss of -48% for the 2.5th percentile. This seems reasonable in light of recent years.

For TIPS, the MCS projects a worst case return over two years of -20%. Could this happen? It's hard to say because TIPS were introduced relatively recently (1997 in the U.S.), but the MCS projected volatility for these bonds is higher than the implied volatility for these bonds: 11% in the MCS vs. 6.8% for options on TIP expiring in March 2010. There is no long-dated market in options on TIP. The trailing three-year realized volatility is 9.1%.

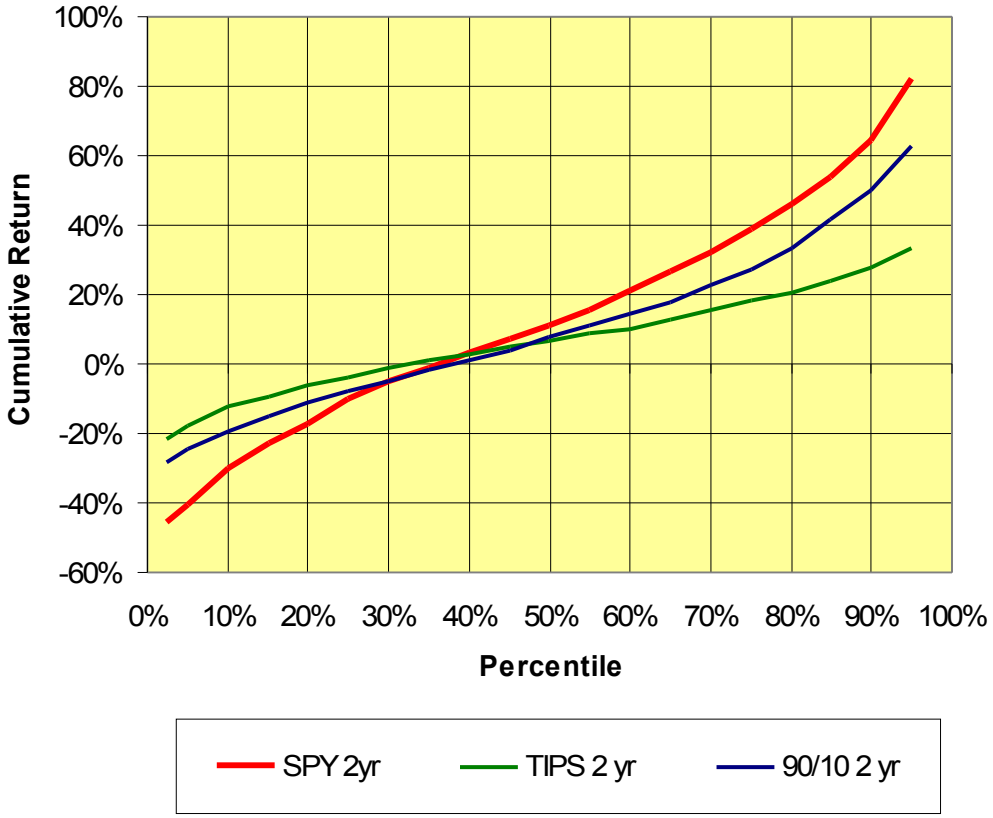
The 90/10 portfolio results (above) very nicely demonstrate the value of this strategy. In the worst case scenario (the far left), TIPS lose 20% and the call options expire worthless, so you have maximum losses on TIPS and the equity markets drop. The 1-in-40 worst case loses 28% — you have not lost maximum amounts on both the TIPS and the options because of their low correlation to one another.

This portfolio loses 28% over two years in its 1-in-40 worst case vs. a loss of 48% for the worst 1-in-40 case for the S&P500 over the two-year period. The 90/10 benefits from its big allocation to TIPS in a worst-case outcome. The S&P500 lost about 45% for the two years through February 2009, and TIPS returned a little more than 4% over this period. A 90/10 investor over this period would be down a little more than 6%, because the call options would expire worthless but the TIPS have appreciated slightly.

It is not until we look at the best outcomes that the strength of the 90/10 is clear. If the S&P500 has a huge rally, the MCS projects that the 95th percentile cumulative two-year return is 74%. The 95th percentile for the 90/10 portfolio is 73% for the two-year period because of the combined effects of both the TIPS having a great run and the call options becoming very valuable. The 90/10 has retained the potential to generate almost as much upside in great years as the S&P500, but it has a considerably tempered downside.

Stress testing

Now let's look at how the effectiveness of this strategy holds up to various stresses. First, let's assume that we end up paying more than fair value for the call options. Let's assume that we paid 25% more than fair value for the two-year options. This might occur because of temporary but extreme market dislocations. This reduces the effective leverage that we get with the call options: You can afford a smaller number of call options with the 10% of the portfolio allotted to options purchases.

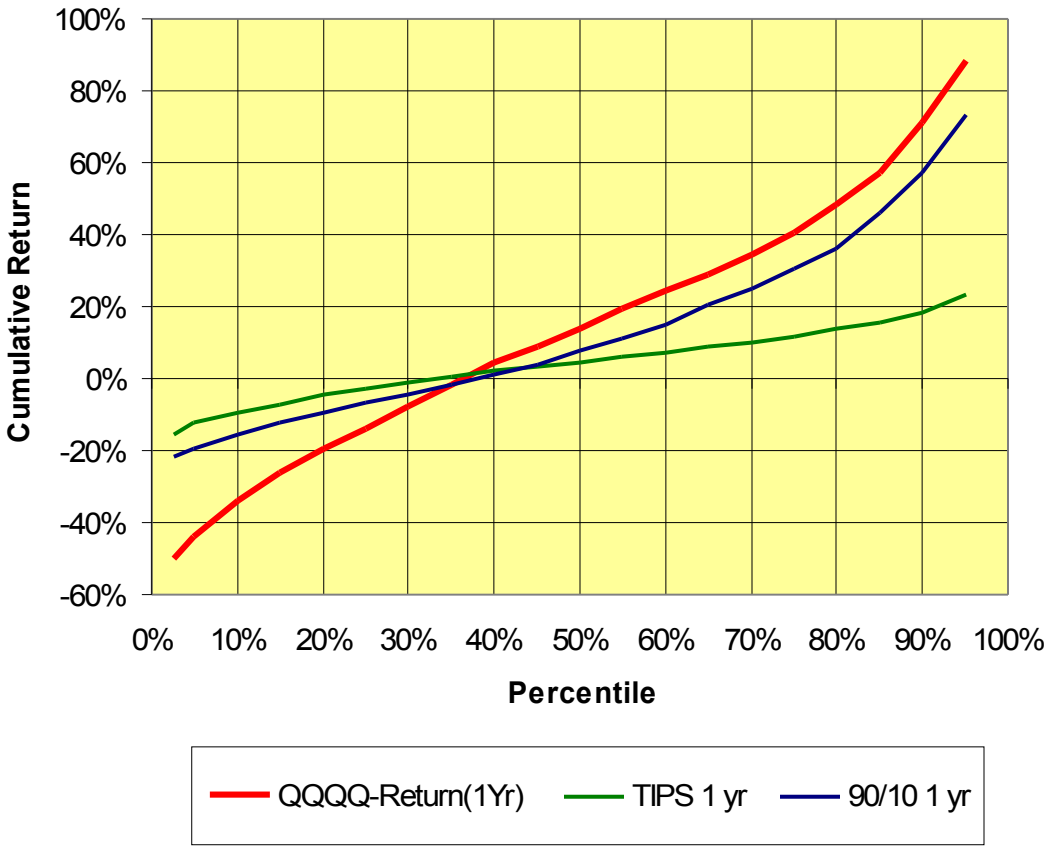


Stress test in which we pay 25% too much for call options

In the case that we pay 25% too much for the call options, the strategy still holds up: We have much less downside than we would with equities, while retaining considerable potential upside from a rally in equities. The effectiveness of the strategy is not highly sensitive to the valuation of the options. The main impact of paying too much for the options is that the effective leverage ratio decreases.

One of the obvious variations on Bodie's strategy is to purchase call options on indexes other than the S&P 500. One might choose to invest in calls in a range of core asset classes or split between multiple indexes. Many of the potentially desirable asset classes for applying this strategy, however, do not have options markets stretching out as far into the future as the S&P 500 does, which is why I have used the S&P 500 in my baseline analysis.

The chart below shows the basic 90/10 strategy implemented with call options on the NASDAQ 100 index (QQQQ) rather than on the S&P 500, but this strategy is implemented using options with a one-year expiration, because the longest-dated options on QQQQ do not go out two years:

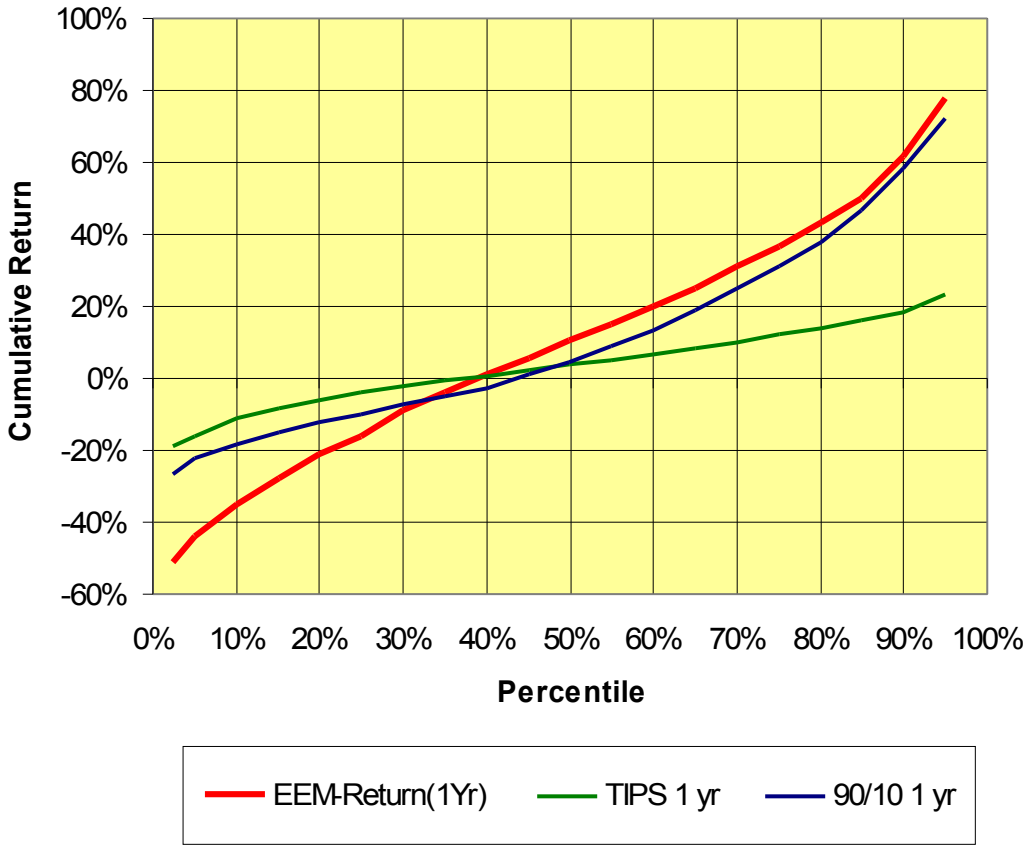


90/10 portfolio with call options on QQQQ

The main effect of using QQQQ is that the total volatility and expected return from the call options increases because QQQQ has higher volatility than SPY. QQQQ has a lower correlation to TIPS than SPY does, which confers a little more in the way of diversification benefit — it mitigates very poor outcomes slightly. QQQQ also has a substantially lower dividend yield than SPY, which increases the potential payout from the call options.

Buying calls on a higher beta / lower yield index ETF adds some additional benefits to the 90/10 strategy. There is an additional change in the outcome of a 90/10 type of strategy in buying calls on options with beta greater than 100% relative to the S&P 500: One can further increase the effective leverage with respect to the S&P 500. Higher beta assets tend to further amplify moves in the S&P 500. The beta of QQQQ is 1.09 (see note at the end of this article).

Let's take this idea a step further with another example. We start with 90% invested in TIPS and 10% invested in one-year at-the-money call options on an emerging market ETF, EEM. EEM has higher Beta than QQQQ, as well as higher volatility (see note at the end of this article). There are, of course, other reasons why one might choose to have equity exposure through emerging markets rather than the S&P 500. EEM's returns have an 89% correlation to returns on SPY and a Beta of 1.46 with respect to the S&P500. The outcome of the 90/10 is shown below.



90/10 portfolio with call options on EEM

In this portfolio, the worst downside is no worse than that from the original 90/10 portfolio because the maximum downside on the equity call options is the 10% of the portfolio paid in options premium.

Conclusions

Bodie's 90/10 strategy can be sanity-checked using Monte Carlo simulations and by benchmarking using the current prices of index options vs. the Monte Carlo model.

Using this framework, it is straightforward to look at how variations of the strategy impact outcomes.

There has never been any doubt that the basic mechanism that Bodie proposed *could* work. The question has been whether such a strategy *would* work in practice, given the prices at which options are trading at any specific time. As the prices of options vary, the effective leverage changes. Given current options prices, the 90/10 strategy makes sense today.

A range of practical variations on the 90/10 type of strategy can make sense for retirement planning. Their main attraction for investors is the absolute floor that they provide on the equity portion of the portfolio.

One of the largest challenges to this type of strategy is its conceptual complexity. On the other hand, as Bodie has noted, equity-linked notes that provide this type of structure to retail investors have been adopted fairly widely in Europe. Advisors who take the time to create their own 90/10 and related strategies can provide a floor on equity market loss potential, while maintaining transparency and keeping costs down.

Notes on the Monte Carlo simulation

The projected returns, volatilities, and correlations for the various asset classes have been generated using ***Quantext Portfolio Planner (QPP)***. The only adjustment to baseline settings is that the volatility of the S&P500 has been raised to 24% to be consistent with current implied volatilities of long-dated options. With this single adjustment, the higher volatility on the S&P500 drives changes in the volatilities of the other asset classes. The results are shown below, along with current implied volatilities of long-dated options.

Ticker	Beta With Respect to S&P500	Projected Volatility	Projected Average Annual Return	Implied Volatility of Long Dated Options
SPY	0.99	24%	8.2%	23.9%
QQQQ	1.09	26%	9.0%	25.5%
TIP	0.17	11%	3.8%	no long dated options
EEM	1.46	35%	12.2%	32.3%

The volatilities projected by QPP are very close to the current market levels, which is reassuring in terms of a consistent spectrum of risk across asset classes.

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