How to Use Bond Ladders in Retirement Portfolios

By Wade Pfau
January 7, 2014

Should bonds be kept in mutual funds or purchased as individual securities and held to their maturity dates? The former option receives much far more attention, as managers compete in a performance-driven marketplace. But investing, especially for retirement, shouldn't be driven by maximizing risk-adjusted returns. Advisors must focus on securing a client's future spending needs. I will investigate the role of bond ladders in retirement and which ladder length is best for clients.

A client's lifetime spending goals represent a stream of liabilities that need to be funded with a retirement income strategy. When the Financial Planning Association (FPA) surveyed[1] its members about their retirement-planning experiences and approaches, it divided retirement income strategies into three fundamental categories: systematic withdrawals, time-based segmentation and essential-versus-discretionary income. You can refer to my June 2012 column for further background about these three strategies.

Time-based segmentation differs from systematic withdrawals in that fixed-income assets are held to maturity to guarantee upcoming retiree expenses over the short and medium term. More volatile assets with higher expected returns are then deployed to cover expenses in the more distant future. Bond ladders are a core component of time-based segmentation strategies. With systematic withdrawals, bonds are generally held in mutual funds.

Due to fears that interest rates may rise, now is a wonderful time to discuss with clients the differences between bond mutual funds and individual bonds when used in retirement-income portfolios. When interest rates rise, bond funds will suffer capital losses. The higher the duration of the bond portfolio (which in the absence of callable bonds is the dollar-weighted average time to maturity for the cash flows, including interest and principal), the greater will be the losses accompanying a rate increase.

Regrettably, too many investors do not understand that their bond funds can register losses as rates rise.

Likewise, interest-rate increases will reduce the value of an individual bond. But, unlike active bond managers, retired clients need not be flustered by this. These capital losses are only relevant if the bond is sold prior to its maturity date. Investors financing a retirement goal can happily ignore the fluctuating value of their individual bonds. The annual return on their portfolio is not the guiding criterion for success, as retirees are instead seeking a sustainable income for life.

Barring default, a bond price naturally creeps toward its face (par) value as the maturity date approaches, no matter how much interest rates have changed. Bond holders will receive the face value at the maturity date. When laddered bonds are held to maturity, cash flows are known and there is no interest-rate risk. Reinvestment risk is also neutralized if income from coupons and maturing bonds is used to finance

[1] FPA membership required for access

spending goals. In fact, rising interest rates could even help with issues such as reducing the IRS required minimum distribution (RMD) amounts for bonds in tax-deferred accounts.

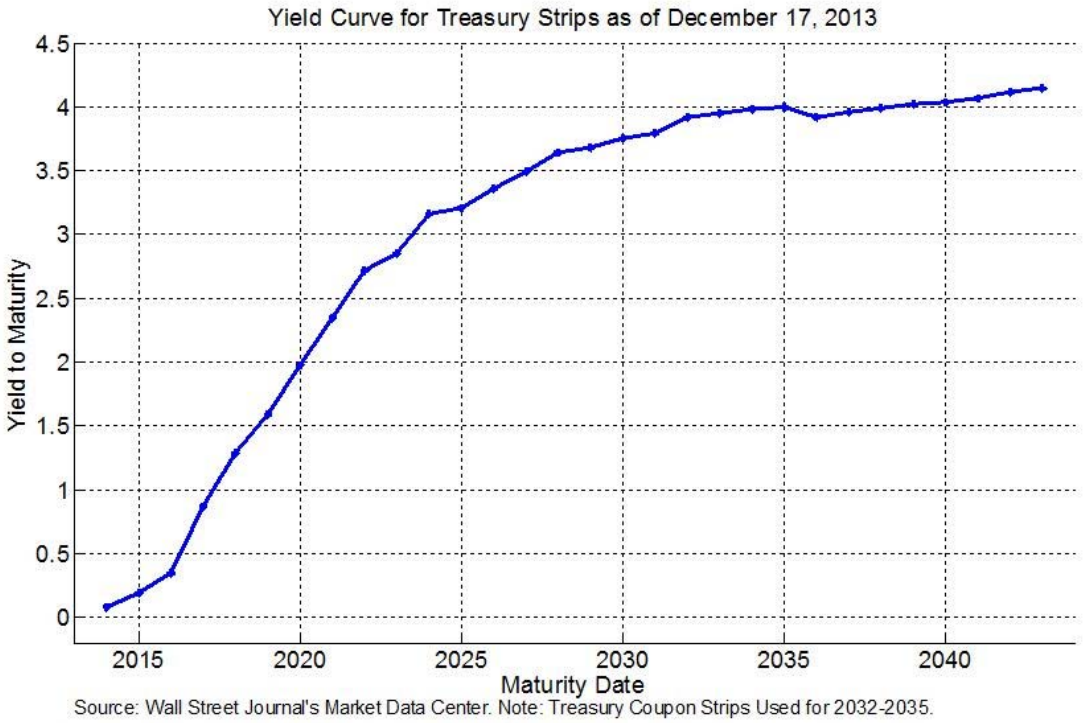
Relatively little information is available to advisors about building bond ladders for retirement income. Perhaps the best source for education about the logic of holding individual bonds is provided in the work of Stephen Huxley and J. Brent Burns, who developed the concept of asset dedication (for instance, see their July 2013 article). With traditional bond ladders, one reinvests assets as they mature into new bonds to extend the ladder. With retirement income, however, income from maturing bonds is spent rather than reinvested. Huxley and Burns criticized bond mutual funds for providing equity-like performance, albeit with lower returns and volatility, in a retirement portfolio. Given bond funds' volatility, it is hard to explain to clients why their asset allocation should be 60/40 rather than 50/50 or 70/30.

For Huxley and Burns, the appropriate way to choose a stock allocation is to use whatever is left over after immunizing one's liabilities, by first creating a bond ladder to lock in upcoming spending needs. Asset classes are used for what they do best: Bonds provide specific income amounts at specified dates and stocks provide growth. This is a form of asset-liability matching, as bonds are used to meet specific cash needs. A client would understand that his or her bond allocation is, for example, 40%, if this is the amount needed to lock in spending goals for a targeted eight-year horizon.

My focus here is to simulate how time-based segmentation can work in practice. My assumption is that most clients will not have saved enough to immunize their entire lifetime of spending. Spending needs may change, so there needs to be some flexibility built into the retirement income approach. Time segmentation calls for the creation of an income floor at the front-end of retirement to meet upcoming lifestyle spending goals, with growth achieved through more volatile equity investments held in the remainder of the portfolio.

Methodology

The *Wall Street Journal*'s Market Data Center provides information on all outstanding Treasury bonds, strips (zero-coupon bonds) and Treasury inflation-protected securities (TIPS). Though it is straightforward to create an initial bond ladder with any of these asset sub-classes, coupon payments increase the complexity when it is time to extend the bond ladder as time passes. For this reason, my investigation focused on strips. I recently discussed the mechanics of building a bond ladder in my blog, using the more complicated case of TIPS. The recent yield curve for strips with maturities extending into 2043 is presented in Figure 1.



I used a few simplifying assumptions in constructing bond ladders, which would require an adjustment when working with clients. First, I used the wholesale asking prices for bonds on the secondary market published in the *Wall Street Journal.* Household investors would have to pay an additional premium above these prices. For instance, Treasury strips prices assume $1 million trading increments. Second, for each year, I used the bond with the earliest maturity date within that year rather than trying to optimize more strategically among multiple maturing issues. Third, the years 2032-2035, do not have any maturing bond issues, as for a time the U.S. Treasury stopped issuing 30-year bonds. For those four years, I used Treasury stripped-coupon interest. I use stripped principal for all other years. Finally, I assumed that factional shares of bonds could be sold. In practice, as bonds can only be purchased in increments of $1,000, there will be minor fluctuations around meeting an income target with maturing issues.

To explain the process more clearly, consider a five-year bond ladder. At retirement, assets are used to purchase a $4 income (which would imply a 4% withdrawal rate if beginning wealth is $100) with a 3% cost-of-living adjustment to cover five years of spending. The remaining assets are placed into stocks. Each subsequent year, enough stocks are sold to purchase a new fifth year of income in order to keep the length of the ladder steady at five years. Another option would be to allow the length of the ladder to vary based on stock performance, but in this investigation I kept the length of bond ladders fixed. I consider bond ladders ranging in length from one to 30 years.

As well, for the purposes of this investigation, I used a new outcome measure developed by Moshe Milevsky at York University. It is called stochastic present value (SPV), and it combines random longevity

with random market returns in each simulation. The SPV calculates how much wealth would have been required at the retirement date to finance the actual spending stream over the client's lifetime. Rather than asking how likely success will be given an initial starting wealth, I am instead asking how much wealth is needed for the retirement to be successful.

Each Monte Carlo simulation includes an age of death for the longest-living member of a 65-year old same-age couple, as well as a sequence of stock market returns and inflation through the age of death. Given that the allocation to stocks is what is left over after building and updating the bond ladder, we can observe how much it would have cost in each simulation to finance an inflation-adjusted spending amount for life. This is different from planning for a fixed period such as 30 or 40 years, and of course the cost of retirement is something which could only be known in hindsight.

But what should worry advisors and clients are the cases when the SPV is greater than the available resources of the client. These are the simulations that would result in a failed retirement. The major advantage of this outcome measure is that it incorporates the randomness in both the length of life and market returns to capture the actual cost of retirement. A disadvantage, though, is that when a simulated retirement is quite cheap, for instance, the measure does not specify if the reason was because of early deaths for both members of the couple or because market returns were extraordinarily high in the early part of retirement.

Without getting too technical, my Monte Carlo simulations assumed the following:

- Today's yield curve stays the same when it comes time to extend the bond ladder.
- The ages of death in each simulation are generated randomly based on the Society of Actuaries 2000 Annuity table data.
- The real return for stocks fluctuates randomly around 7%.
- Inflation fluctuates randomly around 3%.

Analysis

Let us first consider the costs of using Treasury strips to build a retirement income bond ladder of an increasing length. Figure 2 illustrates this within the context of the 4% rule. Assuming 3% inflation, the client desires to have a $4 income growing at 3% each year for the length of the ladder. Figure 2 shows the costs of building ladders of different lengths. It is feasible to build a ladder of approximately 27 years. Beyond that, the costs exceed the assumed wealth of $100.

Figure 2
Cost of Building a Retirement Income Bond Ladder
Providing $4 Annually with a 3% COLA
Using US Treasury Strips on December 18, 2013

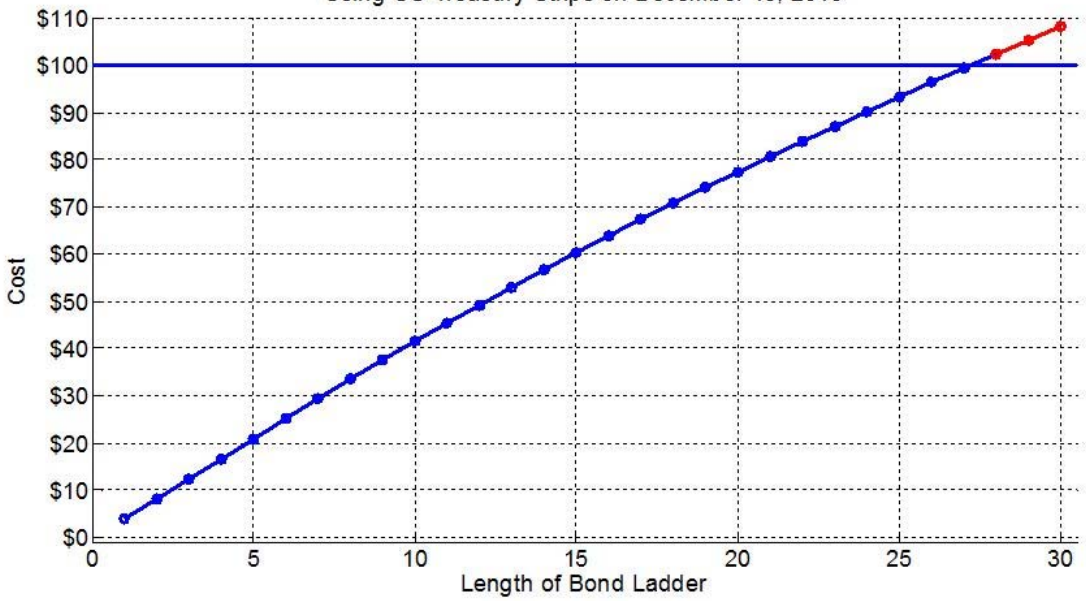


Table 1 provides more information in the same vein. It shows the cumulative cost of building bond ladders of increasing lengths based on the yield curve on Dec. 18, 2013. For a client with $100, a 41.5% allocation to bonds would allow a front-end bond ladder providing 10 years of income. The other 59.5% of assets could be invested in stocks and used to extend the length of the ladder to keep a steady 10-year front-end floor as each year passes.

Table 1

Constructing Retirement Income Bonds Ladders Using Treasury Strips on December 18, 2013

for an Annual Income of $4 with a 3% Annual Cost-of-Living Adjustment

Maturity Date	Coupon Rate (%)	Asking Price	Yield to Maturity (%)	Targeted Spending Amount	# of Shares Purchased	Cost of Shares	Cumulative Cost to Build Bond Ladder of This Length	Implied Portfolio Bond Allocation for Wealth of $100
2014	0	$999.87	0.08	$4.00	0.00	$4.00	$4.00	4.0%
2015	0	$997.85	0.19	$4.12	0.00	$4.11	$8.11	8.1%
2016	0	$992.37	0.35	$4.24	0.00	$4.21	$12.32	12.3%
2017	0	$970.88	0.87	$4.37	0.00	$4.24	$16.57	16.6%
2018	0	$944.72	1.29	$4.50	0.00	$4.25	$20.82	20.8%

2019	0	$921.69	1.59	$4.64	0.00	$4.27	$25.09	25.1%
2020	0	$885.66	1.98	$4.78	0.00	$4.23	$29.32	29.3%
2021	0	$846.06	2.35	$4.92	0.00	$4.16	$33.48	33.5%
2022	0	$791.43	2.72	$5.07	0.01	$4.01	$37.50	37.5%
2023	0	$771.87	2.85	$5.22	0.01	$4.03	$41.52	41.5%
2024	0	$710.20	3.16	$5.38	0.01	$3.82	$45.34	45.3%
2025	0	$700.79	3.21	$5.54	0.01	$3.88	$49.22	49.2%
2026	0	$666.74	3.36	$5.70	0.01	$3.80	$53.02	53.0%
2027	0	$634.13	3.49	$5.87	0.01	$3.72	$56.75	56.8%
2028	0	$589.39	3.64	$6.05	0.01	$3.57	$60.32	60.3%
2029	0	$575.21	3.68	$6.23	0.01	$3.58	$63.90	63.9%
2030	0	$543.22	3.75	$6.42	0.01	$3.49	$67.39	67.4%
2031	0	$524.92	3.79	$6.61	0.01	$3.47	$70.86	70.9%
2032	0	$484.50	3.92	$6.81	0.01	$3.30	$74.16	74.2%
2033	0	$463.13	3.95	$7.01	0.01	$3.25	$77.40	77.4%
2034	0	$442.65	3.98	$7.22	0.01	$3.20	$80.60	80.6%
2035	0	$423.73	4.00	$7.44	0.01	$3.15	$83.76	83.8%
2036	0	$422.69	3.92	$7.66	0.01	$3.24	$87.00	87.0%
2037	0	$402.91	3.96	$7.89	0.01	$3.18	$90.18	90.2%
2038	0	$384.65	3.99	$8.13	0.01	$3.13	$93.30	93.3%
2039	0	$367.24	4.02	$8.38	0.01	$3.08	$96.38	96.4%
2040	0	$351.10	4.04	$8.63	0.01	$3.03	$99.41	99.4%
2041	0	$334.87	4.07	$8.89	0.01	$2.98	$102.38	Not Feasible
2042	0	$317.24	4.12	$9.15	0.01	$2.90	$105.29	Not Feasible
2043	0	$301.75	4.15	$9.43	0.01	$2.84	$108.13	Not Feasible

Figure 3 shows the distribution of costs of funding retirements using bond ladders of different lengths. The solid line is the median, and the dashed lines represent the 1st, 10th, 90th and 99th percentiles of the distributions. Again, the SPV measures the cost of funding a $4 income stream with inflation adjustments for as long as at least one member of a couple lives, based on 100,000 simulations.

We can observe several trends in the figure. First, at the 99th percentile of most costly retirements, risk is greatest with a bond ladder of about three to six years. This would leave the client mostly in stocks, at least initially, which implies greater downside risk. Retirement costs in the worst-case scenario continue to decline as the ladder length increases, even for ladders of up to 30 years in length, though the pace of cost reductions slows for longer ladder lengths. At the 90th percentile of costs, there is no clear pattern between ladder length and the cost of retirement, suggesting some offsetting forces as the ladder length increases. However, as expected, at the median, the cost of retirement increases as the ladder length grows, and less is available for stock investments. The lowest costs, which suggest the most optimistic outcomes,

correspond to shorter bond ladders. These must be cases when stocks do well and clients benefit from greater stock holdings.

Figure 3
Distribution of Costs for Funding Retirement Using Retirement Income Bond Ladders
Providing $4 Annually with a 3% COLA
Using Treasury Strips for Bond Ladders and Stocks for Remainder of Portfolio
For Same-Age Couple at Age 65

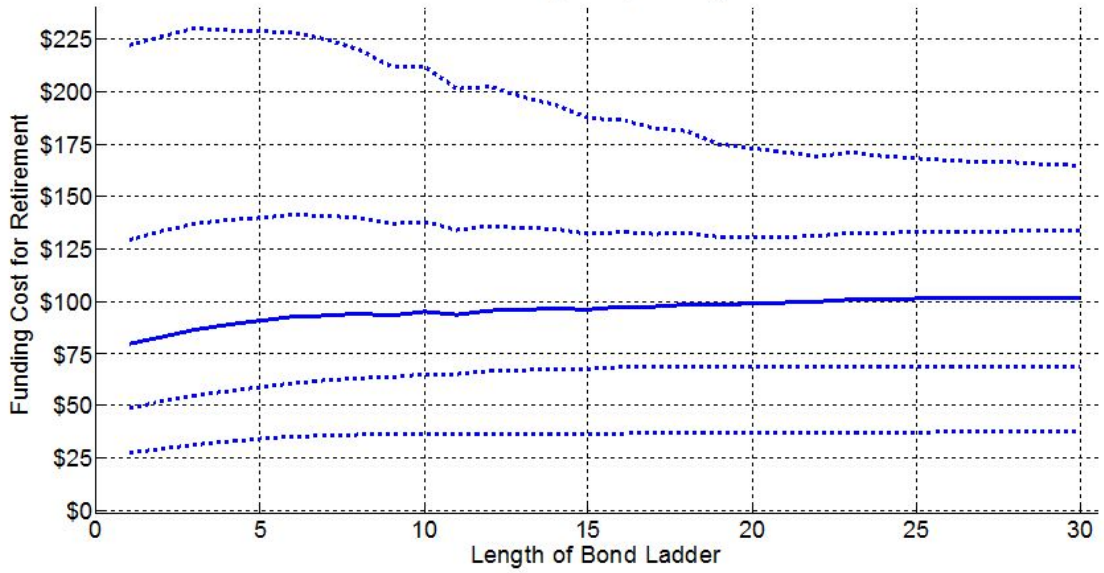
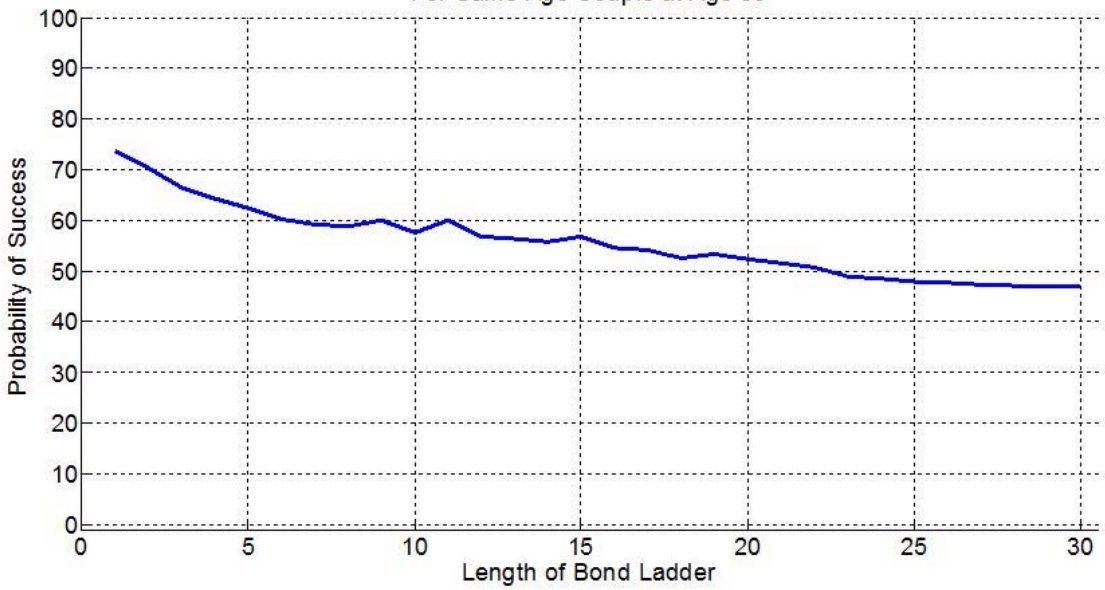


Figure 4 provides a less complete story than Figure 3, but it frames the matter in terms of the more traditional "probability of success" for clients who began retirement with $100. Figure 4 shows the probability that the SPV (the cost of retirement) is less than $100. Figure 3 showed that the median cost of retirement rises with longer bond ladders, and Figure 4 indicates that the probability that $100 is sufficient to fund the retirement falls from just over 70% with a one-year ladder to just under 50% for a 30-year ladder.

Figure 4
Probability of Success When Funding Retirement Using Retirement Income Bond Ladders
Starting Wealth of $100 Sustaining Inflation-Adjusted $4 Annually
Using Treasury Strips for Bond Ladders and Stocks for Remainder of Portfolio
For Same-Age Couple at Age 65



As I mentioned, these figures reveal that there are some offsetting factors that complicate the relationship between ladder length and retirement incomes. When comparing a longer bond ladder to a shorter bond ladder, these factors include:

- The 4% inflation-adjusted spending goal cannot be achieved with the yields on the current yield curve, meaning that one cannot finance retirement with only interest. Principal must be consumed. Yields are the highest at 30 years, but that yield is only high enough to finance a 4.15% withdrawal rate without any inflation adjustment. Stocks are needed to meet spending goals. Bonds are a drag on the portfolio, as they provide less opportunity to get the types of returns needed from a smaller stock allocation to meet lifetime spending goals.

- On the other hand, longer bond ladders have an offsetting characteristic in that the client is able to continue extending his or her ladder at a lower cost using longer maturity strips with a higher yield.

- A shorter ladder makes retirement success more dependent on stocks. Due to stocks' greater volatility and the importance of sequence of returns, retirement costs rise dramatically in worst-case scenarios.

These competing tradeoffs leave advisors with a lot of flexibility in working with clients to customize the bond ladder length. Shorter ladders reduce retirement costs on average, but their worst-case scenarios can

be dramatically worse. The shape of the distribution does not vary all that much once the ladder length extends beyond 15 years. Advisors and clients can work to find the appropriate balance.

Finally, this analysis reveals one very important feature about appropriate market expectations. Looking directly at bond ladders based on today's yield curve reinforces that bond yields are historically low. I often find that advisors are comfortable using historical averages to guide simulations about sustainable retirement spending, but the fact that intermediate-term government bonds historically yielded 5.5% is of no relevance when the yield on five-year strips is currently 1.3%.

The counterargument is that yields are low now, but they will eventually rise, and today's retirees are planning for a time horizon of 30 to 40 years. But this argument is weak, as retired clients spending from their portfolios are especially vulnerable to sequence of returns risk. Low yields mean lower portfolio returns in early retirement, and these low yields will have a disproportionate impact on the final retirement result. What happens later is less important.

Today's retirees will face capital losses with bond mutual funds during the transition to a higher interest rate. Building a bond ladder for retirement income based on today's yield curve makes this matter abundantly clear. Even with a rather optimistic 7% real-stock-return assumption, Figure 4 reveals low probabilities of success for the 4% rule.

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