

Shortfall risk of target-date funds during retirement

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Abstract

Target-date mutual funds are likely to increase in popularity because they are now one of the three approved default options for many retirement plans. In the retirement years, target-date funds become increasingly conservative with higher bond concentrations. Using a bootstrap simulation and rolling period analysis, three target-date fund classifications are shown to have higher probabilities of running out of money and lower balance remaining when compared to fixed allocation portfolios. A fixed 50/50 stock/bond portfolio unambiguously out-performs the target-date funds, regardless of methodology employed. In light of this evidence, these funds should revisit their asset allocation strategy. © 2008 Academy of Financial Services. All rights reserved.

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1. Introduction

Target-date mutual funds change portfolio asset allocation on a prestated schedule based on an investor's current age. Each investor can contribute to a target-date fund that matches their anticipated retirement year and the mutual fund does the rest . . . the mutual fund industry's version of "cruise control asset management." Israelsen (2008) estimates that at the end of 2007, 229 distinct target-date funds with \$177.7 billion in assets were under management. The popularity of such funds is expected to increase because Department of Labor rules have recently designated them as one of the three Qualified Default Investment Options (QDIAs). The focus of this investigation is on a subset of such funds, specifically

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the 131 funds¹ categorized with target retirement dates in the 2000 to 2014 range. The empirical question of immediate interest is: “How effective are such asset allocation schemes in comparison to a self-managed constant allocation?”

In a recent article, Spitzer and Singh (2007) cast some doubt on the wisdom of changing asset allocation during retirement to greater and greater concentrations of bonds, the strategy that is generally pursued by so-called “life-cycle” or target-date funds. This paper shows that the reservations expressed by Spitzer and Singh were warranted. Target-date funds tend to reallocate funds to higher and higher concentrations of bonds in retirement when withdrawals (not contributions) are being made. The rebalancing strategy results in a higher probability of running out of money and a smaller balance remaining at the end of 30 years than portfolios that maintain 50% or more in stock.

2. Target-date funds: A synopsis

2.1. Literature review

Because of the relatively recent introduction of target-date mutual funds, the amount of research on various aspects of these funds is limited. Viceria (2007) examines lifecycle funds in the context of portfolio theory. One of his many conclusions is that when the default choices (in a QDIA) for a defined contribution plan are between a target fund and a money market fund, the target-date fund is preferable.

Bodie and Treussard (2007) suggest integration of human capital risk in the optimization process. One of their conclusions is: “. . . People who are very risk averse and who have a high exposure to market risk through their labor income would experience a substantial gain in welfare from being offered a safe target-date fund rather than a risky one” (p. 47). Bodie and Trussard suggest that the transition from equities to debt in the target-date funds be less linear and more “humped.”

Mitchell, Mottola, Utkus and Yamaguchi (2007) study portfolio compositions before and after the existence of target-date funds. When target-date funds are available, the number of “all equity” or “all cash” portfolios in pension plans decreases. Target-date funds are found to change stock/bond allocations by age group, in part probably because of the additional asset allocation opportunities provided in the target-date funds.

Nagenast, Bucci and Coaker (2006) study the performance and structure of the retail target-date fund offerings of six major fund families. They rank the desirability of the funds on a weighted score of six major parameters: structure/strategy, expenses, allocation, performance and two measures of risk. They conclude that funds generally have performed in line with market returns. They observe that “the asset allocations of most of the fund families lack imagination” (p. 4).

2.2. Target-date fund diversity

Individuals in the 60 to 69 age range are generally either retired or preparing to retire. Target-date funds designated as “2005” or “2010” funds are the appropriate funds for such

Table 1 Description of target-date funds by fund family, starting allocation, ending allocation, and time-to-target

Fund family	Fund name	Ticker	Starting and ending stock/bond allocation*	Time-to-target	Comments
Alliance Bernstein	All-Bern 2005 Retirement Strategy	LTBAX	65/35 35/65	15 Years	
American Century	LIVESTRONG Income Portfolio	ARTAX	45/55 45/55	—	
Guidestone	MyDestination 2005	GMIZX	51/49 25/75	15 Years	
Fidelity	Fidelity Freedom 2005 Fund	FFFVX [†]	50/50 20/80	10–15 Years	
Fidelity	Fidelity Freedom Income Fund	FFFAX	20/80 20/80	—	
Hartford	Hartford Retirement Income	HTRAX	30/70 30/70	—	
Hancock Funds	Lifecycle Retirement Portfolio	JLRAX			Constant real withdrawal of 6% of initial portfolio value
ING Partners	ING Solution	ISWAX	20/80 20/80	—	
JP Morgan Chase	JP Morgan Smart Retirement Income	JSRAX			Discretionary asset allocation
Principal	Principal Lifetime Strategic Income	PALTX	28/72 28/72	—	
Putnam	Putnam Retirement Ready Maturity Fund	PRMAX	13/87 13/87	—	
Seligman Funds	Seligman TargETF Core	SHVAX	65/35 65/35	—	
Scudder	Scudder-DWS LifeCompass	SUCAX			Constant withdrawal rate of 8.125%
State Farm	State Farm Life Path Income	NILAX	38/62 38/62	—	
TIAA-CREF	Lifecycle Retirement Income Fund	TLRRX	40/60 40/60	—	Allowed change of $\pm 10\%$
T. Rowe Price	T. Rowe Price Retirement 2005 Fund	TRRFX	55/45 20/80	30 Years	
Vanguard	Vanguard Target Retirement 2005 Fund	VTOVX	44/56 30/70	10 Years	
Vanguard	Vanguard Target Retirement Income Fund	VTINX	30/70 30/70	—	
Vantagepoint	Vantagepoint Milestone Retirement Income	VPRRX	40/60 40/60	—	Allowed change of $\pm 10\%$
Wells Fargo	Wells Fargo Target Today Fund	STWRX	28/72 20/80	10 Years	Mimics the Dow Jones Target Today Index

*REITs are treated as stocks and included in the stock allocation. Cash equivalents are treated as Fixed Income securities and included in the bond allocation.

[†]Asset allocation is subject to change at advisor discretion.

individuals. Regardless of what target-date fund an individual *currently* owns (say “2040”), the fund will behave as today’s “2005” fund when that person retires (in 2040). Assume a 33-year old contributes to a “2040” fund in 2008. In 2040 when that individual is 65, the “2040” fund will have modified its allocation to be similar to today’s “2005” fund. Since today’s “2040” fund is tomorrow’s “2005” fund, the current inquiry is relevant to all target-date fund owners.

Table 1 provides information about several “Target Date 2005” funds and “Retirement” funds. The starting allocation of stocks and bonds, the ending allocation of stocks and bonds

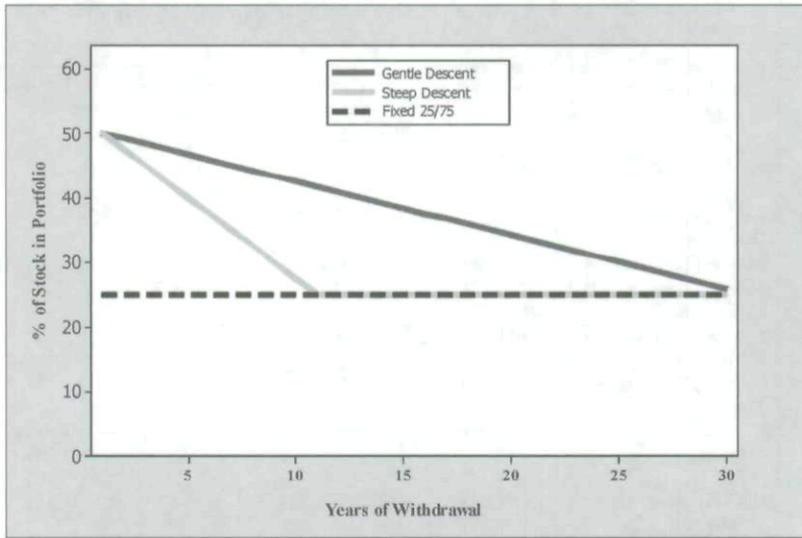


Fig. 1. Three asset allocation strategies used in target PROXY.

and the number of years it will take to get from the starting to the ending allocation (Time-to-Target) are noted in the table. Additional comments are added as necessary. For simplicity in exposition, cash equivalents and preferred securities are categorized as fixed income assets and included in the bonds portion. Similarly, REITs are treated as equity securities and included in the stock allocation. For example, T. Rowe Price Retirement 2005 Fund begins with a 55/45 Stock/Bond allocation, but over 30 years will change the allocation until it attains a 20/80 Stock/Bond allocation, which it then maintains in perpetuity. The Fidelity Freedom 2005 Fund has an initial 50/50 stock/bond allocation that declines to 21/79 over the first 10 to 15 years. Some funds, like the Hartford Retirement Income Fund, maintain a 30/70 allocation throughout. Two of the funds try to provide a constant withdrawal rate.

It is not the purpose of this paper to compare one target-date fund to another, but rather to evaluate the performance of different target-date fund *strategies*. Three broad transparent asset allocation strategies are revealed in Table 1 and shown in Fig. 1.

1. The percentage of stocks falls gradually over 30 years,
2. The percentage of stocks falls rapidly, and
3. The stock/bond ratio is constant.

The three strategies are composites or proxies for actual target-date funds. They will be referred to hereafter as Target PROXYs. The first two PROXYs with changing allocations both begin the retirement period with 50% in stocks and 50% in bonds, and end retirement with 25%/75%. The two PROXYs differ in how quickly they attain their terminal 25/75 allocation. The first PROXY will be referred to as “Gentle Descent” and the second as “Steep Descent.” The third example maintains a “Fixed 25/75” stock/bond allocation throughout the 30-year period. The “Gentle Descent” type corresponds to a target-date fund in Table 1 that has a 30-year glide path to its terminal asset allocation. The “Steep Descent” type corre-

sponds to any of several funds that attain their terminal allocation in 10 to 15 years. These funds have starting stock percentages as high as 65% and terminal stock percentages as low as 20%. The PROXY fund here begins at 50% and ends at 25%. Many of the funds do not change their allocations. With one exception (in the Seligman Funds), the constant allocation funds hold less than 50% stock and as little as 13% (Putnam). The third PROXY classification maintains a fixed allocation of 25% in stocks.

3. Assumptions, investigative methods, and data

3.1. Assumptions

The assumptions are:

- There are six portfolios allocated at 30/70, 40/60, 50/50, 60/40, 70/30, and 80/20 Stocks/Bonds, respectively. These portfolios will be referred to as FIXED funds.
- Three PROXYs are described in Fig. 1. Two of the PROXY funds have a decreasing percentage of stock over time and the third PROXY fund maintains a constant stock/bond allocation of 25/75.
- Given a starting portfolio of \$100, a constant (inflation-adjusted) amount of \$4 (4%) is withdrawn each year. The portfolio will be rebalanced each year after the withdrawal is made.
- Real (inflation-adjusted) rates of return on stocks and bonds are used to calculate the portfolio value as withdrawals take place in each of the nine portfolios. The value of the portfolio will fluctuate over time as rates of return vary and as the size of the portfolio changes.

3.2. Investigative methods

Two separate investigative methods are used in this study because two separate studies have confirmed that conclusions are sometimes sensitive to the investigative technique: even though the same data are used, different methods may arrive at different conclusions. Cooley, Hubbard and Walz (2003) compare results in a retirement withdrawal study using a simulation (Monte Carlo) and using rolling (or overlapping) periods. Although the data are the same, their results sometimes differed between the two methods. They state that they do “not take sides on which methodology is better. The more reliable methodology largely depends on which historical return distribution better reflects the future, which cannot be known” (p. 127). Spitzer and Singh also use two methods in their research: a bootstrap and rolling periods. With the rolling period analysis, Spitzer and Singh conclude that withdrawing bonds first and *not* rebalancing is superior to rebalancing. When using the bootstrap method, the ineffectiveness of rebalancing was less clear. Because simulation and rolling period analysis are sometimes known to disagree, the prudent course is to employ both methods and see what they reveal; both methods are employed here.² The appendix provides complete algorithms for both the rolling period and bootstrap methods.

3.2.1. Rolling period methods

In their section “Temporal Order Analysis Using Historical Sequences,” the Spitzer and Singh paper “looks at all possible 30-year sequences and counts the number of times shortfalls occur. There are 49 overlapping periods of 30 years in the annual data from 1926 to 2003: for example, 1926–1955, 1927–1956. . . 1974–2003” (p. 52). Using exactly the same method and data, the outcomes for shortfalls and balance remaining for the three PROXYs are compared to the six FIXED portfolio allocations.

3.2.2. Bootstrap method

For each of the six FIXED and three PROXYs, 10,000 30-year sequences of withdrawals are performed. Counts of shortfalls are maintained and the average balance remaining is calculated for each of the nine allocation types. It is of special note that each of the nine portfolio types is exposed to precisely the same rates of return on stocks and bonds in exactly the same order.

3.2.3. Data

The data used are the same as used by Spitzer and Singh; annual inflation-adjusted rates of return from 1926 through 2003 for stocks (S&P 500) and bonds (long-term U.S. Treasury bond) are obtained from *Stocks, Bonds, Bills and Inflation: 2004 Yearbook*, Ibbotson Associates. Many of the rolling period outcomes are identical to those reported by Spitzer and Singh. Although the data used could easily have been updated through 2006, the 1926 through 2003 dataset is retained to show the one-to-one correspondence between the results reported here and the Spitzer and Singh rolling period results.³

4. Results

The percentage of times that each of the nine portfolio types runs out of money, as well as the average balance remaining in each portfolio type are compared. In the Rolling Period analysis, all portfolios (FIXED and PROXY) experienced the same stock/bond rates of return in the same (historical) order. In the Bootstrap, all portfolios were provided the same (random selected) sequences of stock/bond rates of return. Since the withdrawal rate is constant at 4% and since the stock/bond return sequences are the same among the nine portfolios, result differences must be solely due to differences in asset allocation.

4.1. Shortfalls

Fig. 2 shows the percentage of Shortfalls for the FIXED and PROXYs over 30 years for both the rolling periods (percent shortfalls out of 49 possible 30-year sequences) and the bootstrap (out of 10,000 replications.) The rolling period results for the FIXED allocations are identical to those in Table 3 of Spitzer and Singh (2007, p. 52) for their Rebalance condition with 4% withdrawals. For the rolling periods (dark bars), the FIXED have fewer shortfalls as the concentration of stocks increases. For the FIXED in the bootstrap (light bars), the number of shortfalls decreases as the stock percentages increase from 30 to 40 to 50%. Shortfalls begin to increase again for FIXED as stock percentages go from 60 to 70 to

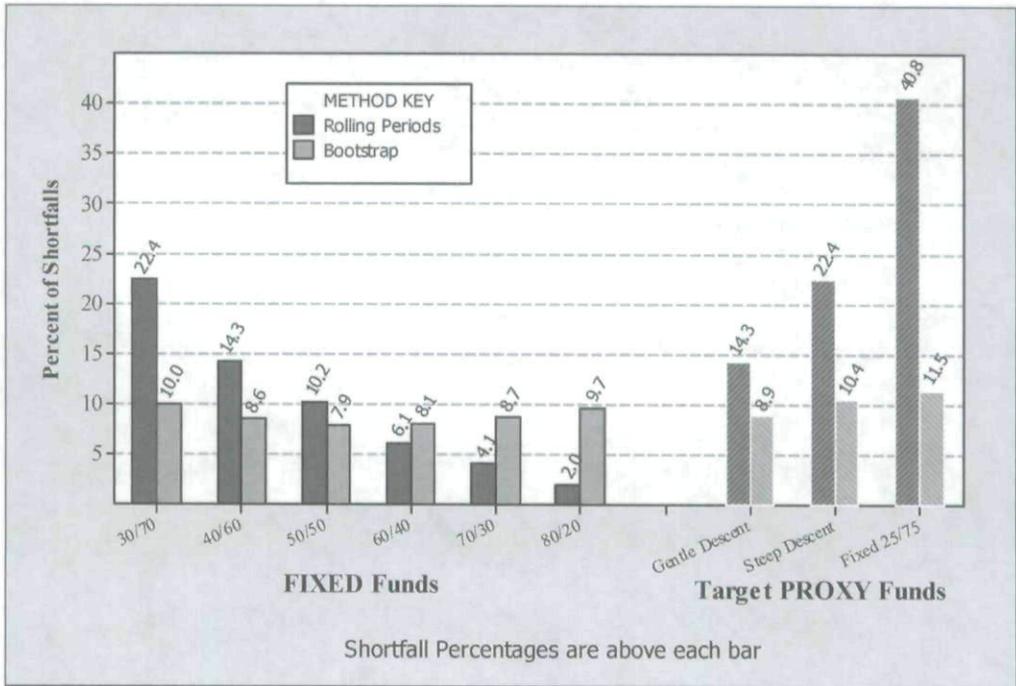


Fig. 2. Percent of shortfalls by allocation strategy and method (bootstrap vs. rolling periods).

80%. Both methods agree that very low levels of stock tend to have higher shortfalls than intermediate levels of stock. However, for the bootstrap, shortfalls increase as stock proportions rise above 60%; shortfalls for the rolling periods continue to decrease as stock proportions rise. Of the three PROXYs, Gentle Descent had the fewest shortfalls, whereas Fixed 25/75 had the most; these results are independent of method. The rolling period results for Fixed 25/75 indicate a very high shortfall rate of over 40%! The bootstrap results for Fixed 25/75 are considerably better at 11.5% shortfalls, but are still more than 3% higher than the shortfall rate of FIXED 50/50.

For both the rolling period and bootstrap method, the performance of the PROXYs is relatively poor compared to FIXED with 50% or more stock. In the rolling period analysis (dark bars), all the PROXYs have shortfalls greater than any FIXED with 50% or more stock. In the bootstrap (light bars), all the PROXYs have shortfalls that exceed the FIXED with 50%, 60%, or 70% stock. Regardless of whether the rolling period or the bootstrap method is used, *FIXED portfolios with 50% to 70% stock provide fewer shortfalls than any of the three PROXY portfolios.*

The bars in Fig. 2 provide some visual measure of performance but do not provide statistical confirmation. Pairwise z-tests on the difference between shortfall proportions of FIXED versus PROXY are made for the bootstrap shortfall data using a one-tailed test. The null hypothesis is: "The proportion of shortfalls for FIXED is at least as great as for PROXY." Tests are not performed for the rolling period analysis because the necessary conditions for the test are not met. Any nonempty cell in Table 2 indicates that the FIXED

Table 2 Statistical differences in shortfall rates between FIXED and PROXY funds for the bootstrap method

FIXED Funds	PROXY Funds		
	Gentle descent	Steep descent	Fixed 25/75
30/70			
40/60		***	***
50/50	***	***	***
60/40	**	***	***
70/30		***	***
80/20		*	***

* = significant at the 0.10 level; ** = significant at the 0.05 level; *** = significant at the 0.01 level.

Asterisks indicate that the hypothesis that “FIXED shortfall rates are at least as large as PROXY shortfall rates” was rejected.

shortfall is statistically smaller than the PROXY shortfall. A simple summary might conclude that *all three of the PROXY funds* have a statistically greater chance ($p < 0.01$) of running out of money than the FIXED 50/50 fund.

4.2. Balance remaining

Fig. 3 shows the Average Balance Remaining in the 49 possible 30-year sequences in the rolling period and the Average Balance Remaining in the 10,000 replications for the

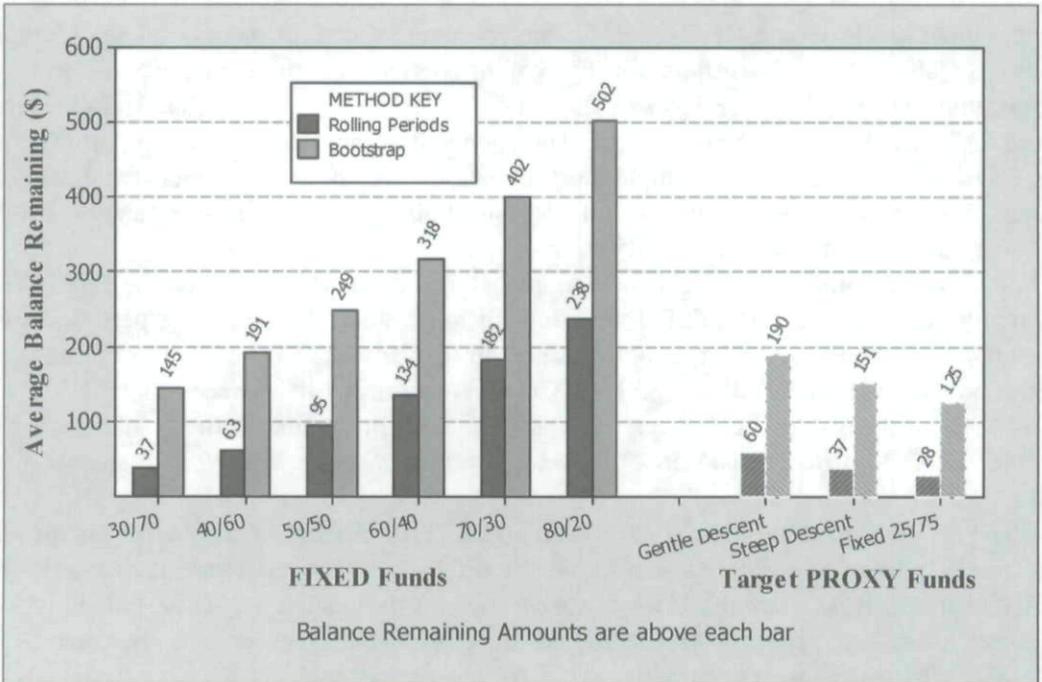


Fig. 3. Average balance remaining by allocation strategy and method (bootstrap vs. rolling periods).

bootstrap.⁴ The rolling periods and bootstrap agree that Average Balance Remaining for FIXED increases as the concentration of stocks *increases*. For the rolling periods (dark bars), any FIXED portfolio with 50% or more stock ends with an Average Balance Remaining in excess of any of the PROXYs. The same statement can be made for the bootstrap method (light bars): FIXED provides a larger average legacy after 30 years than does PROXY as long as the stock proportion is 50% or more.

5. Conclusions

Six nontarget funds with fixed asset allocation (FIXED) are compared to three Target PROXYs using rolling periods and bootstraps. Holding the inflation-adjusted withdrawal rate constant at 4% of the starting balance, each portfolio is subjected to the same rates of return on stocks and bonds and the rates are used in exactly the same sequences. Two attributes are of interest: (1) the shortfall rate (how frequently the portfolios ran out of money) and (2) how much money remains in the portfolios after 30 years. Because the withdrawal rate is constant and because the return rates do not differ among the portfolios, performance differences between the PROXYs and the FIXED must be attributed to asset allocation differences. Without ambiguity, FIXED with 50% to 70% stocks have lower shortfall rates and higher Balance Remaining amounts compared to any of the three PROXYs in each of the two methods. Target-date funds are marketed for their management ease and their perceived safety in the long run; those who elect target-date funds in retirement believe that decreasing equity exposure in retirement provides more income certainty. The findings here suggest that target-date funds are subject to a higher shortfall (longevity) risk and do not provide larger estates. Investment companies currently offering such funds should rethink the asset allocation strategy of these funds.

These results should not be taken as an indictment of all target-date funds. The allocations that target-date funds provide for those at the start of their investment lifecycle may be exactly “on target.” On the other hand, these findings may be unsettling for retirees. There are scores of investment houses that are offering retirement target funds similar to the Gentle Descent, Steep Descent, or Fixed 25/75 asset allocations. Retirees may be erroneously comforted by the “increased security” provided by rising bond proportions in their portfolios. The chances of running out of money before 30 years are greater, not less, when asset allocations suggested by target-date funds are implemented in retirement. Clearly, advisors and financial planners have a valuable role in informing retirees about the possible shortfall risk of target-date funds.

Notes

1. Fidelity Freedom Funds explains the source of their Morningstar rating for 2000–2014 funds at the bottom of Web pages for those funds. For example, see <http://tinyurl.com/32tun4>, accessed February 21, 2008.

2. Each method has its own distinct advantages and disadvantages. The bootstrap, for example, allows a very large number of samples of size 30 to be taken (about 5.7×10^{56}) and it preserves the correlation between stock and bond returns by using stock/bond pairs from the same year. The bootstrap cannot preserve serial correlations because numbers are not used in their historical sequence. The rolling period does preserve serial correlations but is capable of generating only 49 samples of size 30. Each of the 78 observations is equally likely to be included in a bootstrap sample, but not equally likely to be included in the rolling period method. Cooley et al. note that “the overlapping period approach overweights the return experience of the mid-years . . .” (p. 127).
3. The analysis was also done using U.S. Intermediate-term Treasury bonds with data from 1926 through 2005 in lieu of the United States long-term Treasuries. These results are not shown here. With these data, and using a constant withdrawal of \$4.50 (4.5%), the bootstrap results are similar to those reported here (although the shortfall rates at 4.5% withdrawals is larger than at 4% withdrawals). The statistical results are strongly similar. In particular, the FIXED 50/50 had significantly ($p < 0.01$) fewer shortfalls than any of the three PROXYs.
4. The Balance Remaining distribution is highly right-skewed. Because the median of the distribution is less than the mean, much fewer than half of the Balance Remaining will be at or above the mean. The mean is easy to calculate and serves as a relative measure; that is, because each portfolio is subjected to identical sequences of return, the performance of one portfolio relative to another is a valid comparison.

Appendix: Rolling period and bootstrap algorithm

For both methods, there are nine models. . . the six FIXED and three PROXY. For each model, define B_m and λ_m ($m = 1, 2, \dots, 9$) where B_m is the m -th portfolio balance and λ_m is the m -th stock proportion. The starting values at the beginning of year 1 are $B = \$100$ for all m and $\lambda = [0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.50, 0.50, 0.25]$ for the m models. For $m = 7$ (Gentle Descent), λ will be decremented by 0.00833 each year, so that at the end of 30 years, the stock proportion will be equal to 0.25. For $m = 8$ (Steep Descent), λ will be decremented by 0.025 for the first 10 years. The annual withdrawal amount is $W = \$4$ and is constant. Withdrawals are made at that end of each year.

The value of $B_{m,t+1}$ at the beginning of the $t+1$ -th year is calculated as:

$$B_{m,t+1} = B_{m,t} [1 + \lambda_m R_{s,t} + (1 - \lambda_m) R_{b,t}] - W \quad (A1)$$

$R_{s,t}$ and $R_{b,t}$ are the historical rates of return in year t on stocks and bonds respectively from the Ibbotson data. If $B_{m,t+1} \leq 0$, its value is set to zero; the portfolio has run out of money and a shortfall has occurred. “ t ” is selected differently between the two methods as described next.

Rolling period

- Set $B_m = \$100$, $W = \$4$, set $t = 1925$.
- For $t = T+1, T+30$ and all $m = 1, 2, \dots, 9$, calculate $B_{m,t}$.
- After 30 periods, increment counters (shortfall counts) if any $B_{m,t} = 0$. Cumulate $B_{m,t}$ values for computation of Average Balance Remaining for each m .
- If $T < 1973$, increment T by 1, and go to step b.

Bootstrap

The bootstrap proceeds similarly to the rolling period, with two exceptions:

- The values of $1926 \leq t \leq 2003$ are not sequential, but are randomly generated.
- There are 10,000 sequences of 30 years, not 49.

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