

Exploring the pros and cons of target date funds

Ben Branch^{a,*}, Liping Qiu^a

^a*Isenberg School of Management, University of Massachusetts,
121 Presidents Drive, Amherst, MA 01002, USA*

Abstract

Herein, we explore the potential performance of both fixed allocation and target date strategies using one, five, 10, 20, and 40 year bootstrapping windows. We find not only that the mean accumulations and annuity values rise with the stock allocation percentage but also that both the Sharpe and Treynor ratios are substantially higher for the high concentration stock portfolios. These results challenge the claims of target date funds. If the past performance of the asset classes is a useful guide, the probability that performance will be worse for a high fixed stock allocation is not only small but any underperformance is likely to be relatively modest. © 2011 Academy of Financial Services. All rights reserved.

JEL classification: D14; G11; J26

Keywords: Retirement; Asset allocation; Bootstrap; Target-date funds; Lifecycle funds; Mutual funds

1. Introduction

As defined benefit are replaced by defined contribution pension plans, the risk of providing the desired level of retirement income shifts from employers to their employees. Target date funds, which seek to manage risk over one's life cycle, have sought to tap into the impacted employees' need to manage their newly acquired risk. Herein we explore how effectively such funds manage risk and at what price.

While strategies differ, all target date funds seek to manage risk by varying the ratio of stocks to bonds over the life cycle of participants having a similar anticipated retirement date. The fund's portfolio is structured to seek higher returns at the cost of greater risk (high stock

* Corresponding author. Tel.: +1-413-545-5690; fax: +1-413-545-3858.
E-mail address: branchb@som.umass.edu (B. Branch)

allocation) in the early years. It then migrates to a safer but lower potential return portfolio (high bond allocation) as the targeted date approaches.

2. Literature review

Early explorations of life cycle investing include Arrow and Debreu (1954), Merton (1969), and Samuelson (1969), who examined the multiperiod consumption-investment problem. In practice, the issue focuses on asset allocation over different stages of life.

Both academics and practitioners have explored the pros and cons of a target date strategy. Viceria (2007) finds target date funds to be the preferred to money market funds as a retirement vehicle. Pang and Warshawsky (2011) investigate the risk-return characteristics of target date funds and balanced funds. They find that target date funds are a less risky investment vehicle for retirement wealth accumulation compared with balanced funds, even though the former are still risky in the presence of economic disasters. Likewise, Pfau, W. D. (2010) finds that investors with reasonable amounts of risk aversion may prefer a target date fund approach to aggressive fixed allocation strategies, despite that the latter tends to produce larger wealth accumulation. Bodie and Trussard (2007) advise individuals to take account of the riskiness of their job situation. More specifically, those who are risk averse and "... 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." Mithcell, Mottola, Utkus, and Yamaquchi (2007) find that the introduction of target date funds tends to alter the asset allocation away from all stock and all cash investments toward a more balanced approach which varies with age. Shiller (2005) argues that a target date strategy has the effect of investing more in higher expected return stocks early in the life cycle when the invested sums are small and shifting toward lower expected return bonds later in the life cycle when the invested sums are likely to be much larger. Spitzer and Singh (2008), in a bootstrap simulation analysis, find that three different target date fund classifications had a greater probability of running out of money before the retiree dies than a strategy which invests 50% in stocks and 50% in bonds. Expanding on Liu, Chang, De Jong, and Robinson (2009) and Spitzer and Singh (2008), find that a "bonds first" withdrawal strategy results in a higher success rate than a constant allocation strategy as the time horizon and withdrawal rate increase. In their 2010 paper, Liu, Chang, De Jong, and Robinson (2010) examine whether the glide path strategy used in popular target date funds are more effective during the accumulation phase of the retirement saving. They conclude that the constant allocation strategy appears to be superior to the strategy employed in target date funds. Trainor (2009) finds that target date funds are able to reduce risk and increase the minimum accumulation value but with a substantially lower mean accumulation value. Basu and Drew (2009) in another bootstrap analysis report that sifting toward a high stock allocation as the target date approaches would generally outperform a target date strategy about 90% of time. Basu, Byrne, and Drew (2011) proposes a strategy wherein the change of asset allocation at any stage is based on the portfolio's cumulative investment performance relative to the investors' set target at that stage. Ambachtsheer (2009) is critical of Basu and Drew and indeed bootstrap type analysis in general for two reasons. First he emphasizes the desirability of

achieving a minimal level of retirement income and thus the importance of the worst case outcomes. Second, he argues that bootstrapping analysis which treats each year as an independent observation, ignores the tendency of good and bad years to cluster together. Finally, Wayne (2009), in a post 2008 stock market collapse *New York Times* article, reports that target date funds as a group largely failed to avoid or significantly mitigate the market risk of the 2008–2009 period. In a more recent *New York Times* article, Hawthorne (2011), such funds are said to have learned a lesson from the 2008 stock market collapse and are now “. . . de-emphasizing stocks and adding investments that are more diversified, less likely to make sharp moves and more likely to provide a steady income.”

As a relatively recent arrival on the investment scene, target date funds' historical performance is too short to facilitate an effective examination of how they are likely to perform over long time periods with varying market cycles. Accordingly, herein we use historical market data on stock and bond returns to simulate target fund performance. We follow a modified version of the bootstrap methodology of Basu and Drew (2009), Spitzer and Singh (2008), and Trainor (2009).

3. Retirement plans and annuities

The structures of defined benefit plans illustrate what those shifted into a defined contribution plan may be seeking from their retirement plan. Defined benefit plan participants expect to earn a post retirement income that is fixed, secure, and knowable. Typically the payment rate is based on a set of variables including the retirees' length of service, age at retirement and wage/salary history. Such a plan might provide a pension equal to 2% of an employee's immediate preretirement income times the number of years worked. Thus one, who worked 30 years for the same employer, would receive a pension equal to 60% of his or her preretirement income level that, when coupled with other income sources, would generally finance a lifestyle comparable to that previously enjoyed. Thus, the typical objective of retirement planning is not to accumulate some specific sum but rather to allow the retiree to live comfortably on a secure income stream.

With a defined contribution plan such as an IRA, Keogh, or 401K, both employee and/or employer make periodic payments into a designated retirement account. The participant can generally choose one or more investment vehicles from a menu that may include a target date fund. The value accumulated at retirement can be utilized to provide income in at least two ways. One approach periodically withdraws a set amount, such as 4% or 6% of the initial sum. The account's value would vary over time based on the combined impact of the fund's investment return and withdrawal rate. The retiree, however, has no assurance that the sum in the account would be sufficient to provide the planned income for his or her remaining life. A combination of below expected investment performance, a high withdrawal rate and longevity could exhaust the fund during the retiree's lifetime. According to Stout (2008), the average probability of exhausting is more than 25% for a 60-year-old retiree if 95% of his/her retirement portfolio is invested in equity and the withdrawal rate is 6.5%. On the other hand, too conservative an approach to the investment strategy and withdrawal rate could cause the retiree to live much less comfortably than necessary. Life annuities, in contrast, are structured

to provide the retiree with a guaranteed stable lifetime income and thereby overcome the risk of either running out of money or having too much left over. Purchasers of life annuities do, however, incur the risk that the provider will not remain financial viable over the life of the annuitant. Selecting annuities from highly rated providers and diversifying across several providers can mitigate this exposure.

With defined contribution plans no one guarantees that the sum available at retirement will be large enough to purchase an annuity that will provide the needed income level. Both the sum to be available at retirement and the payment stream that it can purchase will depend on the state of the financial markets at retirement. Target date funds are designed to reduce the market fluctuation risk with respect to the variability of the sum to be available at retirement.

The sellers of life annuities take on the risk that annuitants will outlive their actuarial life expectancies. Thus, they absorb the risk that a policy will require more payments than were assumed in pricing the instrument. Some annuitants, however, will die sooner than projected. The insurance companies that sell these annuities use actuarial tables to help establish their prices. The annuitizer guarantees that the income stream will continue for the rest of the annuitant's life, thereby removing the risk that the annuitant will outlive the payment stream. The risk remains that the annuity to be purchased with the accumulated sum may not yield the desired or needed level of income. Determining the sum required to buy an adequate sized annuity is complicated by the reality that annuity prices will not be known ahead of time. Thus, what might have bought an adequate annuity in one market environment may be insufficient in the market conditions that obtain at retirement. The cost of providing annuities, however, tends to vary directly with the level of market interest rates. A given sum of money can buy a larger income stream in a high than low interest rate environment. Stock prices tend to move inversely with market interest rates and bond prices move inversely with interest rates by definition. Thus, the market value of a retirement account containing stocks and bonds should generally vary inversely with market interest rates.

Accordingly, two offsetting forces can be utilized in retirement planning. If at retirement interest rates are low, the value of one's retirement portfolio is likely to be higher than when interest rates are high. However, the cost of annuities will be lower when interest rates are high than when they are low. The extent to which these relationships are offsetting needs to be explored.

Stocks tend to be riskier than bonds. Thus in a risk-averse market setting, stocks should offer the higher expected returns. The past average returns of different asset classes are consistent with this expectation. Accordingly, the size of a defined contribution plan participant's accumulated balance should vary directly with the percentage invested in stocks. Because, however, the variability in the amount accumulated also increases with the percentage invested in stocks, a retirement account having a high stock component is particularly exposed to the possibility that the stock market will be depressed around the time that the plan participant retires. In other words, a high stock component may result in a higher expected accumulation at retirement but also an increased likelihood of being well below that expected value. If, however, stocks are depressed at one's retirement, interest rates are probably high and thus life annuities likely to be less costly. Accordingly, even if one retires when stocks are depressed, the cost of buying a stream of income may be sufficiently reduced to offset a good deal of the impact of having a smaller accumulation. If so, we may find that

seeking higher returns through a relatively high fixed stock allocation during one's working life tends to dominate a typical target date fund strategy. Herein we explore this proposition.

4. Data and methodology

Our analysis utilizes annual inflation-adjusted rates of return from 1926 to 2008 on the S&P 500 Index and long-term U.S. Treasury bonds from Morningstar. We use the annual market yield on U.S. Treasury securities at a 10-year constant maturity from Federal Reserve Statistical Release to estimate the cost of an annuity that an investor can buy at the end of the accumulation period. A two percentage charge is assessed to reflect the cost of investment management and annuitization. We also test a one percentage charge, finding that our basic conclusions are unchanged. The accumulations are calculated by using rolling methods and bootstrap methods with 1-, 5-, and 10-year bootstraps. For the rolling method, each accumulation amount is compounded over 40 consecutive years starting with 1926–1965, 1927–1966 . . . 1969–2008, for a total of 44 overlapping periods. Annuitization costs are computed for the last year of each 40 year time frame.

In the one-year bootstrap, each portfolio contains a random draw of 40 pairs of stock/bond annual return data with replacement from 83 pairs of data ranging from 1926 to 2008. We obtain an accumulation amount by compounding the 40 pairs of stock/bond annual returns as if they were from 40 consecutive years. For example, if our random draw included the years 1929, 1940, 1987, 1993, 2001, and 2006, and another 34 years including some repeats, we would compute the compound value of the set of returns corresponding to those years. The year corresponding to this accumulation amount is the year of the last pair of the 40 randomly withdrawn stock/bond annual returns. This procedure is repeated 100,000 times. The first year end of the rolling method accumulations is 1965. Accordingly, to be consistent with the rolling method, we drop the accumulations whose year end is before 1965.

The one-year bootstrap allows the construction of a very large number of samples of size 40 while retaining the correlation between stock and bond returns by using stock/bond pairs from the same year. Annual bootstrapping does not, however, maintain the impact of any multiyear serial correlation. Applying the bootstrap method to each year's data without regard to returns in prior and subsequent years implicitly assumes that the year following any one year's performance is equally likely to be any year in the database. For example, the return performance following the 1987 stock market crash is as likely to be a year containing another 1987 stock market crash as any other year. Any reversion toward the mean or for that matter any momentum that extends past one year is removed by the use of one year data points. If, however, the market is viewed as moving in cycles with performance in year t having some degree of relationship to performances in any year $t - n$, a different approach to bootstrapping may provide more realistic results. To that end we apply bootstrapping to five and 10 year return increments. Instead of simulating with 40 randomly selected one year returns, the five year bootstrapping uses eight randomly selected five year returns and the 10 year bootstrapping uses four randomly selected 10 year returns.

In the five-year bootstrap, for each portfolio, first we randomly draw eight pairs of stock/bond annual return data from 79 pairs of data ranging from 1926 to 2004. Then, we add the

following four years of return pairs to each of the eight randomly withdrawn return pairs that were previously drawn. In this way we obtain eight sets of randomly withdrawn five consecutive year returns. The rest of the procedure is the same as for the one-year bootstrap. For the 10-year bootstrap we first randomly withdraw four pairs of stock/bond annual returns from 74 pairs of data ranging from 1926 to 1999. Then we add the following nine years of return pairs to each of the four randomly withdrawn return pairs that were withdrawn previously. We could also constructed 20 year bootstraps in a similar manner, although we do not report the specific results.

We wish to explore the mechanics of the various relationships and in the process see how different allocation strategies might work in various market environments. First, we need to estimate the relationship between market interest rates and the cost of annuities. We have yet to find historical pricing information on annuity pricing. We can, however, estimate pricing using the formula for the present value of an annuity:

$$PVoa = \frac{PMT \left[1 - \frac{1}{(1+i)^n} \right]}{i} \quad (1)$$

Where $PVoa$ is the present value of an ordinary annuity, PMT is the amount of each payment, i is discount rate per period, and n is number of payments. We set n at the life expectancy of the annuitant. Implicitly this assumes that the additional cost of providing annuities for those who outlive their life expectancies are offset by the benefit derived from those who under live their life expectancies. The discount rate used here is the inflation adjusted annual market yield on U.S. Treasury securities at a 10-year constant maturity. As previously mentioned, we apply a 2% charge for the cost of providing the annuity. In other words we reduce the market discount rate by this 2% to price each annuity. As an example suppose we find that the present value of a life annuity is 12. That would imply that a life annuity would offer an annual payment rate equal to 1/12 of its cost. Thus, a lifetime annual payment stream of \$1,000 would cost \$12,000.

Our task is to simulate via bootstrapping and rolling method and then compare the various investment strategies of target date funds as well as other approaches to manage retirement accounts. However, rather than focusing on just the distribution of terminal values of the retirement funds accumulated, we also consider the distribution of the corresponding income streams.

5. Results

We start our analysis with a hypothetical individual earning a beginning salary of \$50,000, sets aside 10% of his or her income into a retirement vehicle annually for 40 years (age 25 to 65) when that income is growing at a real (inflation corrected) annual rate of 2%. A male at age 65 would have a life expectancy of about 17 years. Over the 40 year period the individual's income would grow to \$110,402 (\$73,706 at 1%) in real terms. We believe this case to be representative of potential target date investors. We doubt that our results would

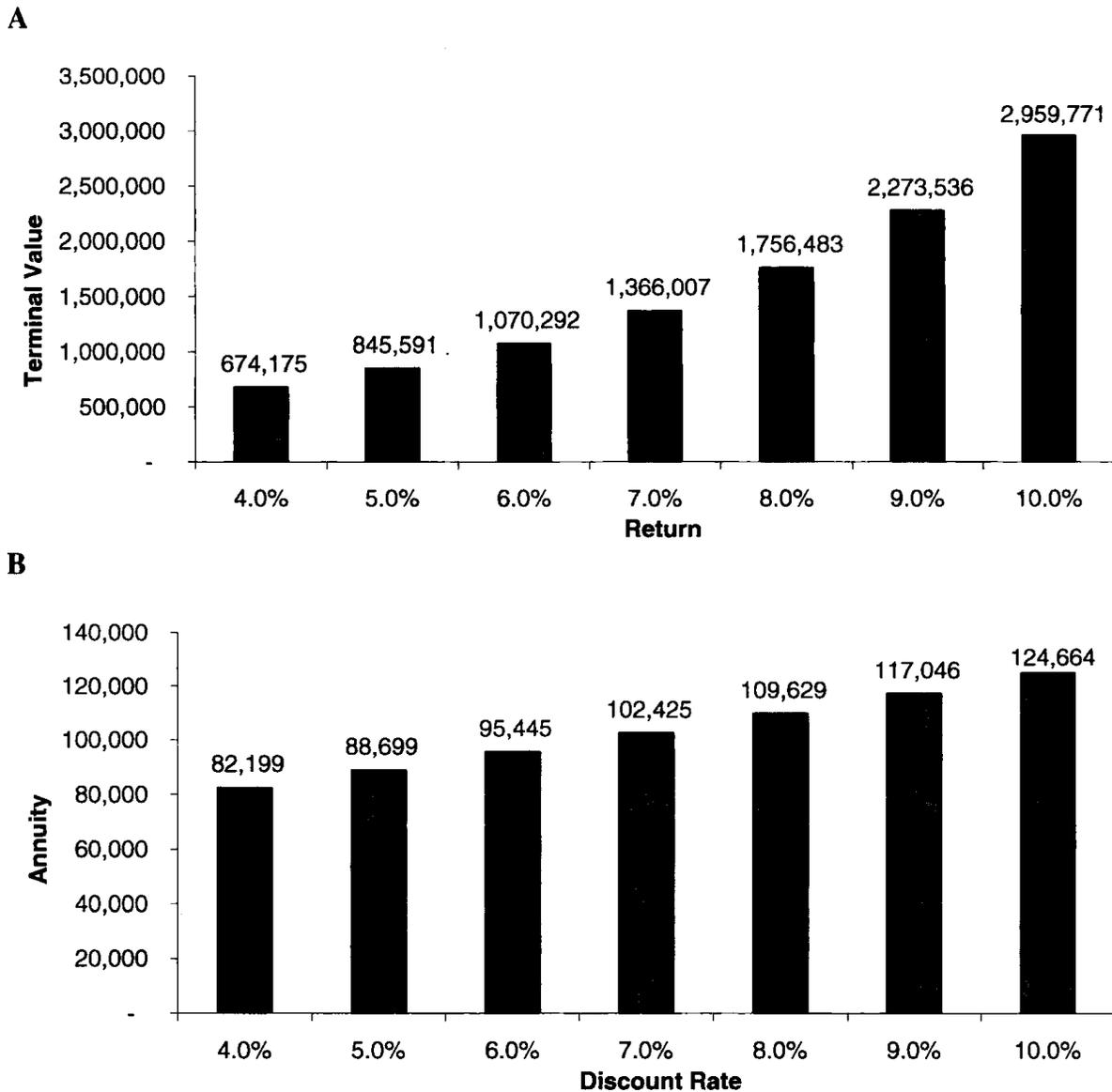


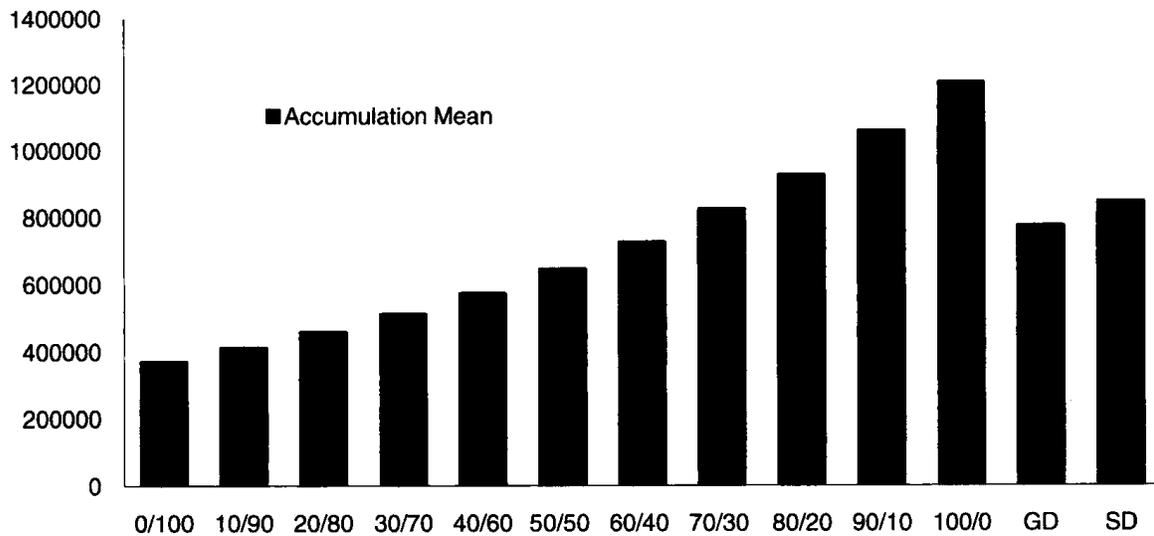
Fig. 1. Relation between terminal value, return, annuity, and discount rate. (A) Terminal values under different returns. (B) Annuities of \$1,000,000 terminal values under different discount rates.

vary greatly for other representative cases. We also tested a 1% growth rate finding that our basic conclusions were unaffected. Fig. 1 illustrates how performance for this fact pattern would vary for return rates that range from 4.0% to 10.0%.

Depending upon investment performance, the retirement account would, for these numbers, grow to somewhere between \$674,000 (4%) and \$2,960,000 (10%). For various market interest rates one might be able to purchase an annuity with an annual payout of between \$82 and \$124 per thousand dollars.

To explore how different allocation strategies might work in various market environments, we apply bootstrapping and the rolling method for a set of fixed allocations ranging from 100% bonds and 0% stocks (0/100) to 0% bonds and 100% stocks (100/0). For target date

A



B

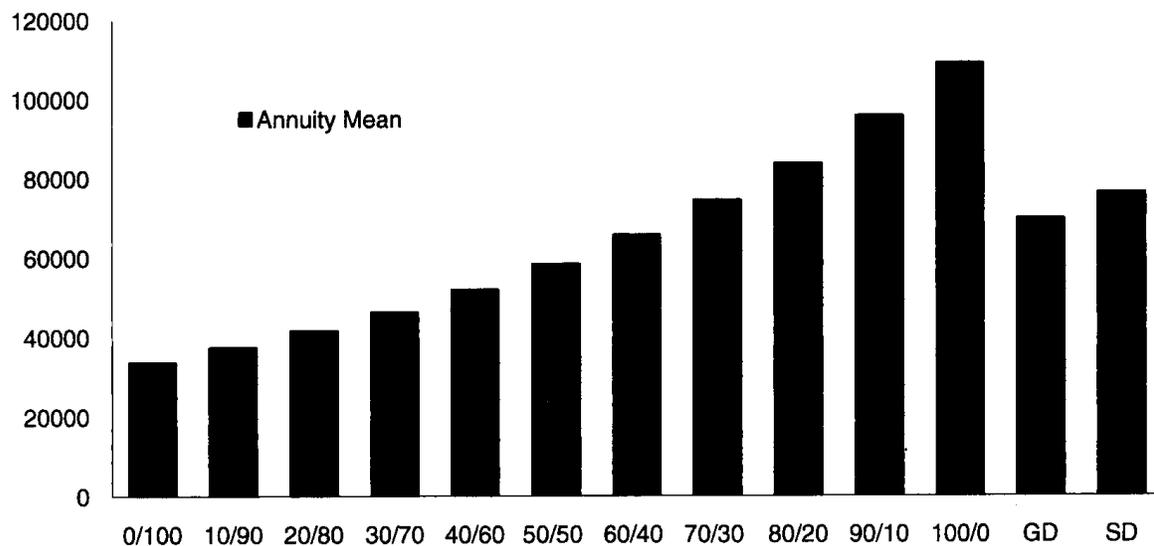


Fig. 2. One-year bootstrapping. (A) Accumulation means from bootstrapping different strategies over 40 years. (B) Annuity means for accumulations from bootstrapping different strategies over 40 years.

funds we apply two strategies which have a decreasing percentage of stock holdings over time. In the gentle descent allocation strategy (GD), the stock proportion decrease from 90% to 50% over the accumulation period. In steep descent strategy (SD), the stock proportion is reduced from the initial 90% to 50% over the last 25 years of the accumulation period. When we apply the bootstrapping method to annual data and take averages we obtain the results contained in Fig. 2 and Table 1.

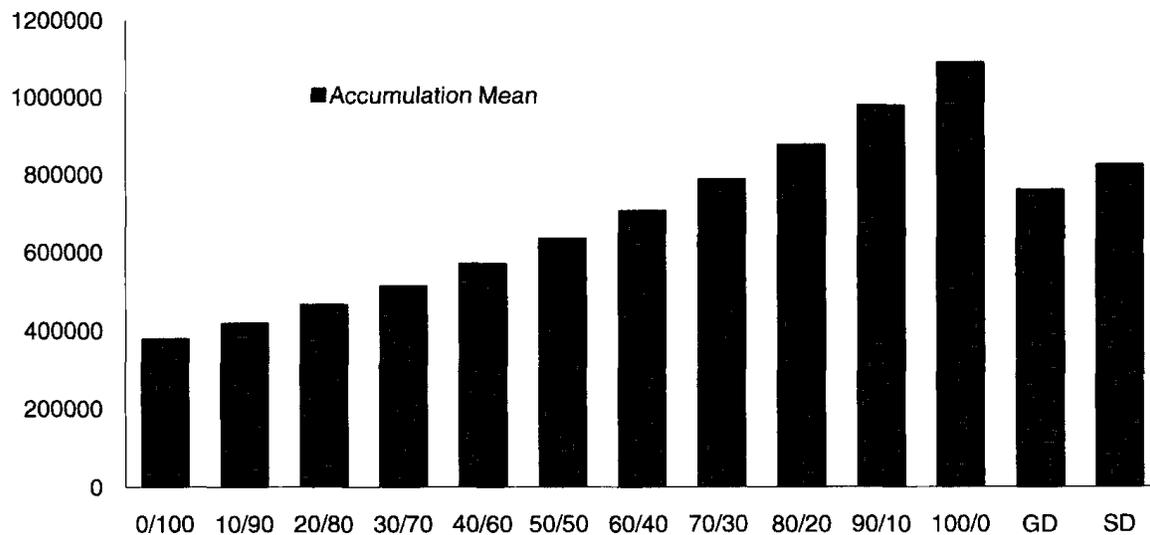
Table 1 Accumulation and annuity statistics of one-year bootstrapping

Accumulation							
Stock/bond	0/100	10/90	20/80	30/70	40/60	50/50	60/40
Accumulation mean	371051	412054	458617	511158	572638	645735	725809
Accumulation STD	143375	153690	173086	204421	254085	324152	423342
IRR mean	0.0114	0.0151	0.0194	0.0239	0.0284	0.0328	0.0366
Sharpe ratio	0.0000	0.2602	0.5252	0.7596	0.9345	1.0653	1.1252
Treynor ratio	0.0000	0.0093	0.0172	0.0235	0.0283	0.0321	0.0344
Stock/bond	70/30	80/20	90/10	100/0	GD	SD	
Accumulation mean	822160	925308	1057580	1204810	772164	843358	
Accumulation STD	556424	732923	994426	1304931	488297	600396	
IRR mean	0.0404	0.0434	0.0465	0.0492	0.0386	0.0411	
Sharpe ratio	1.1635	1.1638	1.1532	1.1435	1.1627	1.1735	
Treynor ratio	0.0363	0.0370	0.0376	0.0378	0.0339	0.0349	
Annuity							
Stock/bond	0/100	10/90	20/80	30/70	40/60	50/50	60/40
Annuity mean	33597	37329	41457	46220	51902	58391	65691
Annuity STD	14585	15849	17736	20667	25425	31600	40801
Mean/STD	2.304	2.355	2.337	2.236	2.041	1.848	1.610
Stock/bond	70/30	80/20	90/10	100/0	GD	SD	
Annuity mean	74417	83772	95756	108908	69837	76324	
Annuity STD	52697	69200	93075	121025	46527	57024	
Mean/STD	1.412	1.211	1.029	0.900	1.501	1.338	

We see that both the mean accumulation and annuity values increase monotonically from the 100% bond to 100% stock allocation. Moreover, all of the allocations from 80/20 to 100/0 have greater mean accumulation and annuity values than either of the target date fund strategies. Indeed the fixed ratios for 70/30 and above have higher mean accumulations than the gentle descent. On the other hand the return variability (STD) also increases with the size of the stock component. To take account of both risk and return simultaneously, we compute both Sharpe and Treynor ratios for each set of simulations (see the Appendix for a discussion these ratios' construction). Both ratios are designed to generate an overall performance score that incorporate the effect of both expected return and risk. The Sharpe ratio takes account of total risk whereas the Treynor focuses on CAPM market risk. Using the Treynor ratio as a risk adjusted performance metric, we find that all of the fixed allocation strategies in which the stock component is 70% or greater exhibit superior performance to either of the target date strategies. The Sharpe ratio results are less clear. The highest Sharpe ratio is found for the steep descent. Both the 70/30 and 80/20 fixed allocation strategy have larger Sharpe ratios than the gentle descent but the differences are small.

As noted previously, applying the bootstrap method to annual data implicitly assumes that the year following any one year's performance is equally likely to be any year in the database. Thus any momentum or reversion toward the mean that extends past one year is removed. If, however, the market moves in longer than one year cycles, a different approach to bootstrapping may be more realistic. To that end we apply bootstrapping to 5, 10, and 20 year return increments. Instead of simulating with 40 randomly selected one year returns the 10 year bootstrapping, for example, uses four randomly selected 10 year returns. Fig. 3 and Table 2 parallels Fig. 2 and Table 1 for 10 year returns.

A



B

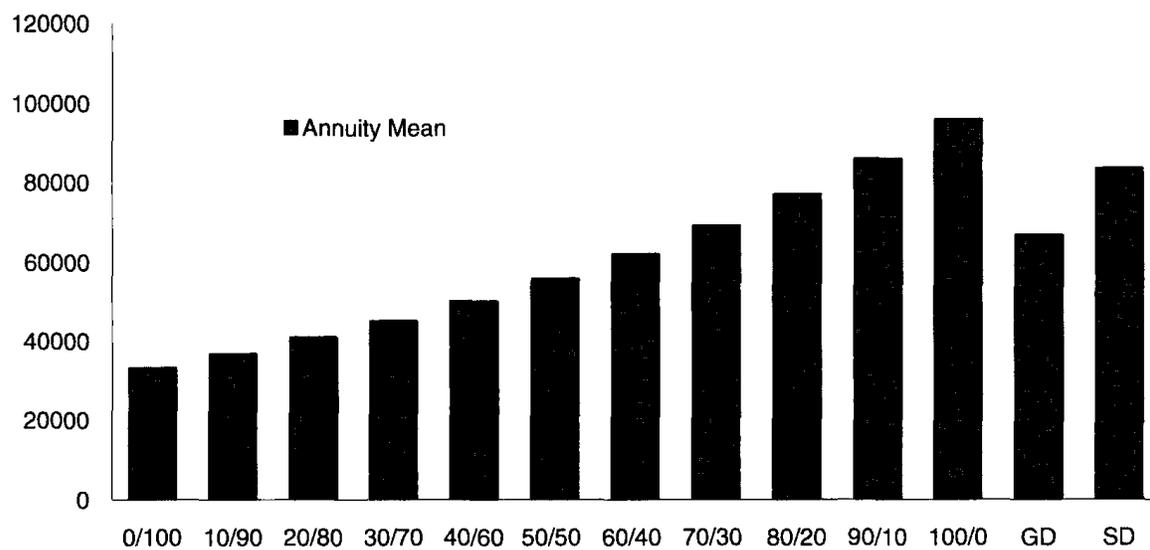


Fig. 3. Ten-year bootstrapping. (A) Accumulation means from bootstrapping different strategies over 40 years. (B) Annuity means for accumulations from bootstrapping different strategies over 40 years.

We see that the mean return results exhibit a similar pattern of rising with the percentage of stock in the account. The variability of returns, however, is considerably less for the 10 year than the one year holding period. Moreover, the mean accumulations and annuity values are lower for high stock concentrations and higher for lower stock concentrations with a 10 year holding period. Interestingly, the Sharpe ratios now rise monotonically with the percentage of stock in the portfolio. For this set of boot strappings the high-stock allocations clearly outperform both target date strategies in terms of both risk metrics. While we do not

Table 2 Accumulation and annuity statistics of 10-year bootstrapping

Accumulation							
Stock/bond	0/100	10/90	20/80	30/70	40/60	50/50	60/40
Accumulation mean	376380	417058	463606	511125	567884	632649	703194
Accumulation STD	186531	205877	229158	252340	285716	327491	380191
IRR mean	0.0128	0.0161	0.0196	0.0232	0.0272	0.0314	0.0355
Sharpe ratio	0.0000	0.1897	0.3688	0.5344	0.6982	0.8591	0.9940
Treynor ratio	0.0000	0.0081	0.0146	0.0195	0.0240	0.0279	0.0309
Stock/bond	70/30	80/20	90/10	100/0	GD	SD	
Accumulation mean	784224	873432	975533	1088180	756923	821975	
Accumulation STD	452710	540549	665117	814257	430568	493755	
IRR mean	0.0394	0.0431	0.0465	0.0498	0.0381	0.0410	
Sharpe ratio	1.1018	1.1902	1.2366	1.2753	1.0676	1.1404	
Treynor ratio	0.0332	0.0350	0.0361	0.0369	0.0314	0.0331	
Annuity							
Stock/bond	0/100	10/90	20/80	30/70	40/60	50/50	60/40
Annuity mean	33125	36691	40770	44948	49966	55699	61852
Annuity STD	15892	17496	19507	21449	24246	27856	32335
Mean/STD	2.084	2.097	2.090	2.096	2.061	2.000	1.913
Stock/bond	70/30	80/20	90/10	100/0	GD	SD	
Annuity mean	68921	76769	85781	95693	66555	83240	
Annuity STD	38512	46043	56756	69499	36626	48482	
Mean/STD	1.790	1.667	1.511	1.377	1.817	1.717	

report the specific results for the five and 20 year bootstrappings, their results are consistent with the 10 year results reported above. Indeed the 20 year results are even more favorable for the high fixed stock allocations.

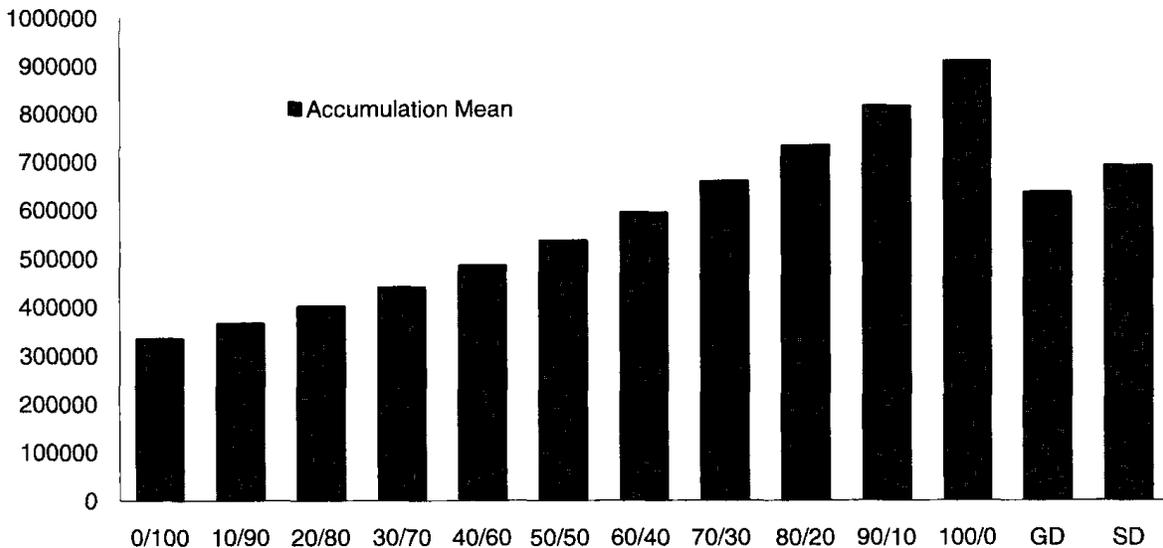
As a further test we compute performance for 40 year periods. Here we average results over the 44 consecutive 40 year periods contained in the 1926–2008 time interval. Fig. 4 and Table 3 contain our results.

The results from the rolling method are especially favorable to the high fixed allocation stock approach. Once again the mean accumulations and annuity values rise monotonically with the percentage of the stock allocation and for the higher allocations favor the fixed over the target allocation. While the variability is greater for the fixed allocations, both the Sharpe and Treynor ratios are substantially higher for the high concentration stock portfolios than they are for the target portfolios.

While a relevant consideration, return variability is not the entire story. Another way to explore the risk/return tradeoff of target versus non target funds is to consider how likely the accumulation and annuity payment rate for a fixed allocation strategy are to be above or below those of a target strategy. If for example, the high stock allocation provides a terminal value which is highly variable but very likely to be above that of the target fund strategy even when below its mean, then that approach may still dominate the target strategy for even highly risk averse participants. Table 4 contains three matrices the first of which reports the probability that a fixed strategy will produce a greater terminal value and annuity payment rate than will a gentle descent strategy.

We see that the probability of a better result from a fixed allocation strategy increases monotonically with both the percentage of stocks and the length of the time period consid-

A



B

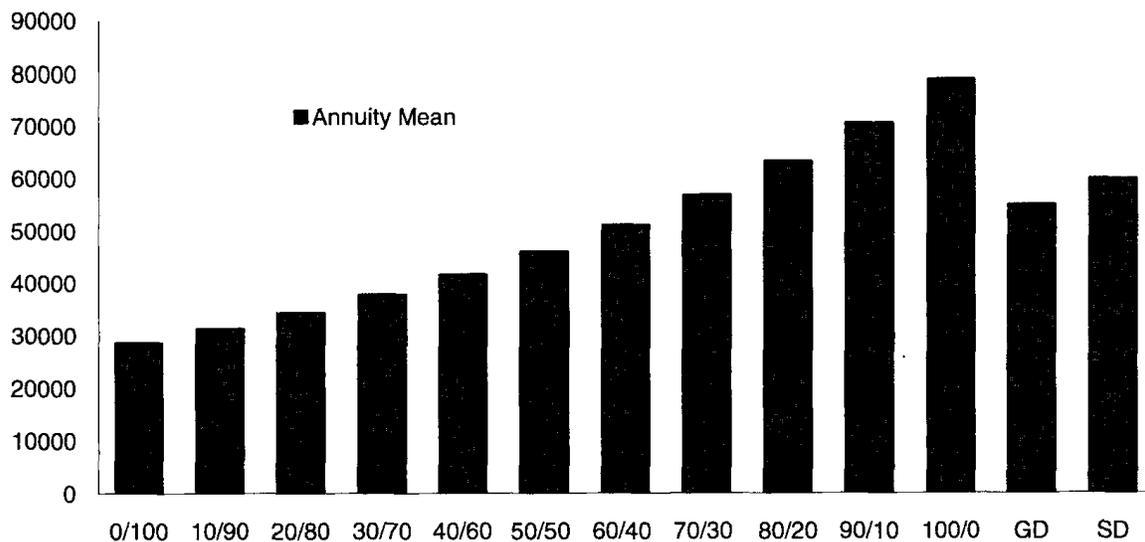


Fig. 4. Rolling method. (A) Accumulation means of different strategies over 40 years. (B) Annuity means for accumulations of different strategies over 40 years.

ered. In particular for 10 year bootstrapping, the chance of having a worse outcome with a 100% stock allocation than with a target fund is only about 34% compared with more than 41% for one year bootstrapping. With the 40 year rolling the odds of a better result with a gentle descent strategy are less than one in 20. Thus, if the appropriate return period length for bootstrapping is 10 years or longer, and these past data provide an accurate guide of the future, an all-stock portfolio approach has better than a two in three chance of outperforming

Table 3 Accumulation and annuity statistics of rolling method

Accumulation							
Stock/bond	0/100	10/90	20/80	30/70	40/60	50/50	60/40
Accumulation mean	334015	365380	400587	440227	484977	535596	592926
Accumulation STD	166199	173887	180787	186928	192671	198969	207675
IRR mean	0.0156	0.0177	0.0206	0.0243	0.0287	0.0334	0.0382
Sharpe ratio	0.0000	0.1140	0.2621	0.4671	0.7221	1.0351	1.4092
Treynor ratio	0.0000	0.0052	0.0106	0.0164	0.0218	0.0267	0.0308
Stock/bond	70/30	80/20	90/10	100/0	GD	SD	
Accumulation mean	657877	731419	814554	908287	634539	689904	
Accumulation STD	221800	245420	282995	338432	191709	189456	
IRR mean	0.0429	0.0475	0.0519	0.0561	0.0420	0.0459	
Sharpe ratio	1.8139	2.2136	2.5663	2.8309	1.9413	2.4820	
Treynor ratio	0.0341	0.0368	0.0389	0.0405	0.0328	0.0356	
Annuity							
Stock/bond	0/100	10/90	20/80	30/70	40/60	50/50	60/40
Annuity mean	28510	31204	34239	37670	41558	45973	50990
Annuity STD	11139	11520	11796	11958	12026	12077	12295
Mean/STD	2.559	2.709	2.902	3.150	3.456	3.807	4.147
Stock/bond	70/30	80/20	90/10	100/0	GD	SD	
Annuity mean	56694	63170	70510	78805	54860	59796	
Annuity STD	13003	14643	17635	22250	10305	9295	
Mean/STD	4.360	4.314	3.998	3.542	5.324	6.433	

a target strategy. With a 20 year bootstrapping, the odds favor the all stock portfolio over three fourths of the time.

As a further test we divide our outcomes into two categories. In the first, we place those cases when the fixed strategy outperforms the gentle descent. In the second we place those where the gentle descent does best. Next we compute the average percentage amount by which a fixed stock allocation strategy outperforms the target strategy for the first case. Then we look at the amount by which the fixed stock allocation strategy underperforms the target strategy when the target strategy outperforms. Matrices are computed for the four return period lengths and the 40 year rolling period with various allocation strategies. As an example consider the 100% stock column (100/0-GD). The topmost number, 139.64 is the average percentage amount by which the 100% stock allocation outperforms the gentle decent in those cases where it does outperform that for the one year bootstrapping is around 59% of the time. The number below it, 64.04%, is the percentage amount by which the gentle decent outperforms the 100% stock allocation in the 41% of the time when it does. Moving down the column we see the corresponding numbers for five, 10, and 20 year bootstrapping as well as for the rolling method. Below this matrix is a similarly constructed matrix for annuity values.

Looking at the 100% stock column we see that the average amounts of over and underperformances generally decrease as the holding period increases from one year to 10 and 20 and then on to rolling for both the terminal value and annuity size. A similar pattern is observed for the other stock/bond allocations. In other words, performance is less extreme when we look at longer return periods. That result is consistent with a reversion toward the mean behavior for stocks. Good years do not always follow bad years and vice versa but most

long term periods have tended to contain some good and bad years such that the average return for a 10 and 20 year periods are less variable than that of a randomly selected group of 10 or 20 one year returns (where the individually selected one year returns can contain some repeats of the same year). We submit that the bootstrapping results for the 10 and 20 year periods are more reflective of how markets work than that for the one year periods. We reason that the economy and corporate sales, profits and dividends all tend to grow at a more or less well defined long term rate that tends to drive stock prices as also growing approximately at such a rate. To the extent that shorter term forces move stock returns either above or below that long term rate, a movement back toward a more normal return is likely to occur sooner or later. Thus, stock prices and returns are expected to exhibit a revision toward the mean more often than momentum that would drive returns away from that long term mean.

Now looking across the rows note that the average outperformance increases as the stock percentage is increased for all four return periods. The pattern is less clear for the underperformance rows. For the 10 and 20 year return periods we note a tendency for the percentage of underperformance to decrease as the stock percentage increases.

The annuity story is very similar to that of the accumulation matrix. The amounts by which the high stock allocation strategies outperform the gentle descent strategy in case one are much greater than the amounts by which the gentle descent outperforms in Case 2. Far more of the probabilities are in case one (high stock allocation outperforms) than Case 2 (gentle descent outperforms). The annuity matrix is even more favorable to the high stock allocation strategy than are the accumulation results.

6. Conclusions

These results challenge the claims that target date funds are an effective retirement planning vehicle. We see that if the past performance of the asset classes is a useful guide, a heavily weighted constant allocation stock portfolio is likely to outperform a target date strategy by a large margin in terms of raw and risk adjusted returns as measured by both the Sharpe and Terynor ratios. Equally important, the probability that the performance will be worse for the all stock allocation is not only small but the underperformance when that happens is relatively modest. On the other hand, the high fixed stock concentration portfolio is likely not only to outperform the target date strategy, but do so by a large margin.

We need to make clear the usual caveats. This analysis is based on the assumption that past return experience by asset class is a worthwhile basis to project future relative asset class returns. Similarly, we have analyzed a particular hypothetical situation. We believe it is representative. None the less other situations may yield rather different outcomes. Finally, we have simulated life annuity contract costs. Real world contracts may be priced rather differently.

Appendix

Treynor ratio (Treynor, 1965) and Sharpe ratio (Sharpe, 1966) are widely used risk-adjusted performance metrics.

The Sharpe ratio is defined as:

$$S_i = \frac{\bar{R}_i - \overline{\text{RFR}}}{\sigma_i}$$

Where:

\bar{R}_i is the average of the IRR of each accumulation generated by the bootstrapping or rolling method for strategy i .

RFR in its original definition is the average rate of return on risk-free investment. In this paper, $\overline{\text{RFR}}$ is the average of IRR for the benchmark strategy that has the lowest risk. Because among all the strategies considered in this paper, the one with 100% bond has the lowest risk, it is used as benchmark strategy.

σ_i is the standard deviation of the IRRs for strategy i .

The Treynor ratio differs from the Sharpe ratio in that the Treynor ratio is the risk premium return earned per unit of systematic risk (beta) rather than per unit of total risk. Specifically the Treynor ratio is defined as:

$$T_i = \frac{\bar{R}_i - \overline{\text{RFR}}}{\beta_i}$$

Where:

\bar{R}_i and $\overline{\text{RFR}}$ are defined as above.

β_i is the systematic risk for strategy i . It is the weighted-average of the systematic risks of bond and stock components. For example, for the 80/20 strategy, $\beta_i = 0.8 \times \beta_s + 0.2 \times \beta_b$.

Where:

β_s is the beta of stock which is 1 because the returns for stock utilized in this paper are the returns on S&P 500 Index.

β_b is the bond beta which is calculated from the following regression:

$$R_s = \alpha + \beta_b R_b + \varepsilon$$

Where R_s is the monthly inflation-adjusted rate of return from 1926 to 2008 of the S&P 500 Index and R_b is the monthly inflation-adjusted rate of return from 1926 to 2008 on long-term U.S. Treasury bonds. The coefficient β_s is used for the systematic risk of bond.

References

- Ambachtsheer, K. (2009). Turning the Life-Cycle Finance Theory on its head: Should older workers have high equity allocations? *The Ambachtsheer Letter*, August 2009.

- Arrow, K. J., & Debreu, G. (1954). Existence of an equilibrium for a competitive economy. *Econometrica*, 22, 265–290.
- Basu, A., & Drew, M. E. (2009). Portfolio size effect in retirement accounts: What does it imply for Lifecycle Asset Allocation funds. *Journal of Portfolio Management*, 35, 61–72.
- Basu, A., Byrne, A., & Drew, M. E. (2011). Dynamic Lifecycle strategies for Target Date retirement funds. *Journal of Portfolio Management*, 37, 83–96.
- Bodie, Z., & Treussard, J. (2007). Making investment choices as simple as possible, but not simpler. *Financial Analysts Journal*, 63, 42–47.
- Hawthorne, F. (2011). *Shifting Strategies for Target-Date Funds*. New York Times, March 2.
- Liu, Q., Chang, R. C., De Jong, J. C., & Robinson, J. H. (2009). Reality check: The implications of applying sustainable withdrawal rate analysis to real world portfolios. *Financial Services Review*, 18, 123–139.
- Liu, Q., Chang, R. C., De Jong, J. C., & Robinson, J. H. (2010). *Glidepath Strategies for Retirement Funds: Boon or Boondoggle?* University of Hawaii at Manoa. Working paper.
- Merton, R. C. (1969). Life time portfolio selection under uncertainty: The continuous-time case. *Review of Economics and Statistics*, 51, 247–257.
- Mitchell, O. S., Mottola, G. R., Utkus, S. P., & Yamaguchi, T. (2007). *The Dynamics of Lifecycle Investing in 401(k) Plans*. The Wharton School, University of Pennsylvania. Working paper.
- Pang, G., & Warshawsky, M. (2011). Target-date and balanced funds: Latest market offerings and risk-return analysis. *Financial Services Review*, 20, 21–34.
- Pfau, W. D. (2010). Lifecycle funds and wealth accumulation for retirement: Evidence for a more conservative asset allocation as retirement approaches. *Financial Services Review*, 19, 59–74.
- Samuelson, P. (1969). Lifetime portfolio selection by dynamic programming. *Review of Economics and Statistics*, 21, 239–246.
- Sharpe, W. F. (1966). Mutual fund performance. *Journal of Business*, 39, 119–138.
- Shiller, R. J. (2005). Lifecycle portfolios as government policy. *The Economists' Voice*, 2, article 14.
- Spitzer, J. J., & Singh, S. (2008). Shortfall risk of target-date funds during retirement. *Financial Services Review*, 17, 143–153.
- Stout, R. G. (2008). Stochastic optimization of retirement portfolio asset allocations and withdrawals. *Financial Services Review*, 17, 1–15.
- Trainor, W. J. (2009). *Target Date Funds Trade-off of Expected Return for Reduced Risk*. East Tennessee State University. Working paper.
- Treynor, J. L. (1965). How to rate management of investment funds. *Harvard Business Review*, 43, 63–75.
- Viceira, L. M. (2007). *Life Cycle Funds*. Harvard Business School. Working paper.
- Wayne, L. (2009). Mutual funds with target, and misfires? *New York Times*, June 25.