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Adding "value" to sustainable post-retirement portfolios

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Abstract

Balanced mutual funds, long used in individual retirement plans, have increased in popularity in recent years, partly because they are one of three qualified default investment alternatives in employer-sponsored retirement plans. Using mean-reverting valuation metrics, we design semi-passive balanced fund portfolios with significantly lower shortfall rates and higher remaining balances than those found in studies like Bengen (1994) and Spitzer and Singh (2008). The results from our study, using rolling periods and bootstrapping simulation methods, indicate that our valuation-based portfolios unambiguously outperform both conventional balanced funds and target-date funds, and that they should be included as additional offerings in retirement plans.

JEL classification: D14; D91; G11; J26

Keywords: Retirement portfolios; Asset allocation; Bootstrap; Target-date funds

1. Introduction

The creation of the 401(k) employer-sponsored defined contribution retirement plan in 1980 gave individuals power over their own retirement plans. Unfortunately, data show that many individuals make poor choices with respect to whether to invest, how much to invest and where to invest. These poor choices can result in individuals having insufficient retirement income to maintain their living standards. In this article we develop a valuation-based approach to forming retirement portfolios that can be used by relatively unsophisti-

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cated investors to make informed retirement portfolio choices as well as portfolio managers who are making retirement portfolio decisions for others.

Behavioral finance theorists explain the suboptimal investment choices of individual investors in terms of psychological factors affecting their decision-making processes, such as framing, inertia, and procrastination as well as Simon's (1957) concept of "bounded rationality."[1] If individuals are unwilling or unable to make reasonable investment choices, giving them free choice to select from unlimited options may result in suboptimal choices leading eventually to the failure or malfunctioning of the retirement system. Clearly a retirement system failure or malfunction has crucial societal implications.

An indication of the acceptance of behavioral finance tenets by Congress occurred when the Pension Protection Act, H.R. 4 of the 109th Congress, was signed into law in August 2006 (ERBI, Issue Brief, No. 301, January 2007). Section 624 of the Act extends "Safe Harbor" from fiduciary liability for investment losses to employers (plan sponsors) who automatically enroll employees in 401(k)s. One goal of giving employers Safe Harbor was to increase enrollment in 401(k) plans for those employees who stayed in the plans, but failed to make investment selections. The bill named three qualified default investment alternatives (QDIAs) into which employees can be automatically enrolled, target date funds, balanced funds, and managed accounts. Our focus will primarily be on portfolio allocations in balanced funds, funds whose allocations to stocks and bonds tend to be either fixed or maintained within specified ranges, with some discussions of target date funds. Although we do not discuss managed retirement accounts, they typically follow allocation principles similar to those underlying balanced funds and target date funds. Thus, our approach could be generalized, at the minimum, to any type of QDIA.

We use the Federal Register's (Vol. 72, No. 205 October 24, 2007, pp. 60479–60480) distinction between target date and balanced funds. The Register states that target date funds "… change their assets allocations over time with the objective of becoming more conservative … with (the participants') increasing ages." Balanced funds on the other hand are "… designed to provide long-term appreciation and capital preservation through a mix of equity and fixed income exposures consistent with a target level of risk appropriate for the participants of the plan as a whole." Based on this distinction, balanced funds should have more flexibility, because they only have to conform to a "target level of risk for … the plan as a whole," whereas target-funds are supposed to have "the objective of becoming more conservative … with (the participants') increasing ages."

We develop a valuation-based approach to forming balanced retirement portfolios that is based on findings and models from the contemporary finance literature. The valuation-based methodology we create is based on the observed mean-reverting properties of financial metrics such as the price-earnings, price-to-book, and price-dividend ratios, and lends itself readily to creating low-cost, semi-passive, balanced portfolios from two liquid index portfolios. Using rolling period and bootstrapping simulations to compare strategies, we find that our portfolios generate higher returns and smaller losses than commonly used balanced fund and target date fund strategies. For example, employing our strategies would have reduced equity allocations *before* such economic crises as the Great Crash of 1929, the NASDAQ market crash of 2000, and the financial crisis of 2008, thereby mitigating significant losses in retirement portfolios.

Although we usually will discuss retirement portfolio strategies designed for QDIA-eligible portfolios, it should be noted that our strategies can be used in the design of portfolios with other purposes, and by portfolios managers and individual investors alike. In addition, because the allocation strategies we develop are relatively easy and inexpensive to implement, even unsophisticated individual investors can use them to rebalance their retirement or other portfolios. All else equal, self management will have a substantial positive impact on portfolio performance because of lower investment expenses. For example, Breuer and Collins (2011) find that the simple average expense ratio for a fund of funds (of which target-date and balanced funds are types) in 2010 was 136 basis points. In contrast, the Vanguard's S&P 500 index fund has an expense ratio of 17 basis points and the largest S&P 500 ETF has an expense ratio of nine basis points. Self management using our simple reallocation strategies will result in more than a 100 basis point performance improvement over fund-related expenses compared with the average fund of funds.[2] Fund expenses in investment selection are so important that a recent Morningstar study (Kinnel, 2010) concludes: "Investors should make expense ratios a primary test in fund selection. They are still the most dependable predictor of performance." Therefore, our results should be of importance and benefit to individual investors, whether they are making their own decisions or allowing others to make the decisions.

2. Literature review

There is existing evidence that fixed-allocation balanced funds should outperform target-date funds. Spitzer and Singh (2007) find that the conventional wisdom of rebalancing portfolios in retirement to gradually increase bond allocations, while reducing stock allocations, is of questionable merit. Expanding on their earlier work, Spitzer and Singh (2008) show that fixed 50/50 and fixed 70/30 stock-to-bond portfolios unambiguously outperform target date fund strategies, both by decreasing the probability of shortfall and by increasing average remaining balances. Pang and Warshawsky (2011) found that, during the recent financial crisis, target-date funds displayed greater variation in risk-return performance as compared with balanced funds, and that the higher variability was driven primarily by differing asset allocation levels and glide paths. Because of this disparity in target-date funds' performance, the SEC has recently proposed that target-date funds provide more disclosures enabling greater transparency and increased investor awareness of their strategies.[3]

We create postretirement balanced funds with stated initial allocations like Spitzer and Singh's funds; however, while their portfolios are rebalanced annually back to their initial allocations, we allow the initial allocations to change based on well-defined decision rules. The decision rules specify threshold level of certain mean-reverting valuation metrics that, when exceeded, trigger annual changes in the initial portfolio allocations. The resulting portfolios outperform those of Spitzer and Singh, both by having lower probabilities of shortfall and by having higher legacy values.

Our use of mean-reverting metrics is supported by a large body of finance literature. Poterba and Summers (1988) and Fama and French (1988) find that stock returns display "mean reversion" (are negatively serially correlated) in the longer term (one year to five years).[4] Balvers, Wu, and Gilliland (2000) find strong evidence of long-term mean reversion in 18 different national equity markets. DeBondt and Thaler (1985, 1987), Chopra, Lakonishok, and Ritter (1992), and Richards (1997) find that buying portfolios of long-term losers and shorting portfolios of long-term winners produces abnormal returns. In effect, the literature suggests that stocks that have gone up (down) in the past few years, reverse direction in the next few years and go down (up).

If long-term stock returns are mean reverting, then there should be a predictable (stationary) component to these returns.[5] Campbell and Shiller (1988) find that stock market valuation ratios such as the price-earnings and price-dividend ratios are predictors of future stock returns. Fama and French (1993) show that book-to-market ratios explain stock returns. Campbell and Shiller (2005) and Harney and Tower (2003) find that the valuation ratios are mean-reverting; if valuations drift very far from the norm, stock prices will eventually adjust to force valuations back to the mean. As stated in Harney and Tower (2003):

> Stock prices should demonstrate a fundamental relationship with the ability of firms to generate profits, expressed in the form of earnings. The magnitude of PEs (price-earning ratios) should thus demonstrate investors' valuations of company profits. The existence of a fundamental relationship between equity valuations and corporate profits, however, constrains the degree to which PEs can rationally fluctuate, so these ratios should revert to their means. Sufficiently low PEs reflect an overall undervaluation of the stock market; conversely, sufficiently high PEs suggest investors overvalue the ability of firms to generate profits. Consequently, above average investment returns should follow periods exhibiting relatively low PEs and below average investment returns should follow periods with comparatively high PEs.

We find that using the mean-reverting properties of price-earnings, price-dividend, and price-to-book ratios to design balanced, adaptive, postretirement portfolios can significantly reduce shortfall rates and increase legacy values. We suggest that the traditional approaches to minimizing risk in retirement, whether through classical balanced fund or target-date fund strategies, do not account for the risk that an asset category may be significantly overvalued and may remain so for an extended period of time. As evidenced by the stock market's performance from 2000 to 2010, extreme overvaluation may lead to extended time periods during which investors would have fared better by holding portfolios with lower allocations to stocks than is employed in typical target-date funds or balanced funds.

Mitchell (20011), Stout (2008), Spitzer (2008), and Stout and Mitchell (2006) study the use of proactive *withdrawal rate strategies* to increase portfolio survival rates. While these strategies do improve retirement portfolio performance, they may be too complex for many individual investors, and may require unacceptable reductions in retirees' spending patterns during market or economic downturns. We instead consider dynamic *asset allocation strategies* that are significantly less complex and more intuitive for the typical individual investor, and should have no affect on their annual withdrawals.

We test our strategies using bootstrapping and rolling period models with historical returns to simulate multiple withdrawal rates and portfolio allocations in retirement. Simulation models like these are used extensively by finance practitioners in designing retirement portfolios that can better sustain withdrawals over long periods.[6] Although a known short-

Table 1 Valuation metrics

	Valuation metrics		
	P-E10	P-B	P-DIV10
Mean	19.0	1.21	36.8
Median	17.7	1.17	33.4
Standard deviation	7.6	0.43	19.5
Maximum	46.5	2.29	102.6
Minimum	6.5	0.27	9.4
Sample size	84	84	84

Note: Summary statistics of the valuation metrics are reported for valuation ratios calculated at the start of each year from 1926 to 2009.

coming of the bootstrapping technique is that it ignores the impact of serial correlation, our method mitigates this impact of serial correlation by using mean-reverting valuation metrics.

3. Definitions, data, and methods

3.1. Data collection

We assume that a portfolio manager's asset allocation decision-making process begins at the start of the year. Accordingly, we calculate our valuation ratios annually just before the start of the year. To better reflect the longer-term cyclicality of business earnings and cash-flows, we follow Graham and Dodd (1937) and Campbell and Shiller (1988, 2005) in using normalized 10-year earnings and dividends to calculate the price-earnings and price-dividend ratios, respectively.[7] In the Robert Shiller data from his website,[8] the normalized price-earnings ratio (P-E10) is calculated as the S&P 500 index at the start of each year divided by an average of the most recent 10-years of S&P 500 earnings; and the normalized price-dividend ratio (P-DIV10) is calculated using an average of the most recent 10-years of S&P 500 dividends.[9] Price-to-book ratio (P-B) is obtained from Kenneth French's website[10] as the median breakpoint of price-to-book ratios calculated at the start of each year for all stocks listed on the NYSE. Annual stock and bond data from 1926 to 2009 for the U.S. markets are obtained from Ibbotson Associates (2010). In line with other studies, we use real (inflation-adjusted) S&P 500 returns for stocks and real long-term treasury returns for bonds to more easily accommodate inflation-adjusted increase in annual dollar withdrawals.

Table 1 contains summary statistics of the three valuation metrics. As is evident from the data in the table, the ratios vary considerably over time. From 1926 to 2009, the normalized price-earning ratio has ranged between 6.5 and 46.5 (average 19.0), while the range for the normalized price-dividend ratio was 9.4 to 102.6 (average 36.8). During the same period, the S&P 500 traded between 0.27 times and 2.29 times book value (average 1.21). Worthy of note, all three ratios were much higher than their historical averages before the start of significant market downturns; for example, the normalized P-E was 24.1 at the start of 1929, 46.5 at beginning of year 2000, and 28.8 at the start of 2008.

3.2. Portfolio strategies

We define a "static" balanced-fund strategy as one in which the portfolio is rebalanced annually to the initial fixed or "baseline" stock/bond allocation. A "semi-passive" or "adaptive" balanced fund strategy is one in which the portfolio is rebalanced annually to the baseline stock/bond allocation, with a further "adaptive" 25% adjustment in allocation being possible. This adaptive adjustment is made only if the underlying mean-reverting valuation metric has deviated at least one-half a standard deviation from its mean.[11] For example, in an adaptive portfolio with a baseline allocation of 50/50, if the P-E10 ratio of the S&P 500 were to rise above 22.8, then the portfolio's allocation would be changed from the baseline 50% stocks and 50% bonds to 25% stock and 75% bonds.

Below are individual characterizations of the four different portfolios strategies. Note that all rebalancing occurs at the start of the year.

- STATIC strategies: Portfolios will be rebalanced annually to the baseline target stock/bond allocations. These portfolios are like those used in Bengen (1994) and Spitzer and Singh (2008) and like many of the classical balanced portfolios popular in current retirement portfolios.
- ADAPTIVE P-E10 strategies: If the S&P 500's normalized price-earnings ratio is greater (less) than its historical mean plus (minus) one-half its historical standard deviation, the stock allocations in the rebalanced portfolios will be decreased (increased) to 25% below (above) their baseline allocations.
- ADAPTIVE P-B strategies: If the stock market's price-to-book ratio is greater (less) than its historical mean plus (minus) one-half its historical standard deviation, the stock allocations in the rebalanced portfolios will be decreased (increased) to 25% below (above) their baseline allocations.
- ADAPTIVE P-DIV10 strategies: If the stock market's normalized price-dividend ratio is greater (less) than its historical mean plus (minus) one-half its historical standard deviation, the stock allocations in the rebalanced portfolios will be decreased (increased) to 25% below (above) their baseline allocations.
- Similar to Spitzer and Singh (2008), we form portfolios with initial stock/bond allocations of 30/70%, 40/60%, 50/50%, 60/40%, and 70/30%. We then apply the four portfolios strategies (three adaptive strategies and one static strategy) to each of these five different initial allocations, producing a total of twenty portfolios (these will be called the 20 "reference" portfolios). Within each initial stock/bond allocation, we can compare the performance of the three different adaptive portfolio strategies both to one another and to the static portfolio strategy.
- Table 2 contains the annual performance statistics of the four portfolio strategies applied to the five different stock/bond allocation schemata for the period from 1926 to 2009. Consider the Panel C results for balanced portfolios with initial stock to bond allocations of 50/50. Based on their mean rates of return, each of the adaptive portfolios has in the past outperformed the static portfolio. The P-DIV10 adaptive portfolio had the smallest outperformance at 0.89%, while the P-E10 adaptive portfolio had the largest outperformance at 1.38%. All three adaptive portfolios had higher standard

Table 2 Annual portfolio strategy returns

	Portfolio strategies			
	Static	Adaptive P-E10	Adaptive P-B	Adaptive P-DIV10
Panel A: 30/70 stock/bond portfolio				
Mean return	4.61%	5.99%	5.63%	5.50%
Median return	4.39%	5.23%	5.23%	5.04%
Standard deviation	10.18%	11.83%	11.98%	11.96%
Sharpe ratio	0.38	0.45	0.41	0.40
Panel B: 40/60 stock/bond portfolio				
Mean return	5.18%	6.57%	6.21%	6.08%
Median return	4.62%	5.38%	5.41%	5.17%
Standard deviation	10.94%	12.68%	12.85%	12.78%
Sharpe ratio	0.41	0.46	0.43	0.42
Panel C: 50/50 stock/bond portfolio				
Mean return	**5.76%**	**7.14%**	**6.78%**	**6.65%**
Median return	**4.70%**	**5.61%**	**5.92%**	**5.61%**
Standard deviation	**12.06%**	**13.83%**	**14.02%**	**13.91%**
Sharpe ratio	**0.42**	**0.46**	**0.43**	**0.43**
Panel D: 60/40 stock/bond portfolio				
Mean return	6.34%	7.72%	7.36%	7.23%
Median return	6.32%	6.21%	6.21%	5.83%
Standard deviation	13.45%	15.21%	15.42%	15.28%
Sharpe ratio	0.42	0.46	0.43	0.43
Panel E: 70/30 stock/bond portfolio				
Mean return	6.91%	8.30%	7.94%	7.81%
Median return	8.38%	6.11%	6.11%	6.23%
Standard deviation	15.04%	16.78%	16.99%	16.82%
Sharpe ratio	0.41	0.45	0.43	0.42

Note: Annual returns statistics are presented for various portfolio strategies. Adaptive portfolios are created using a 25% adaptive weight–portfolio weights change (decrease/increase) by 25% if the valuation metric (P-E10, P-B, P-DIV10) at the start of the year falls outside the range [mean ± 1/2 standard deviation]. Our study uses the following valuation metric ranges based on results from Table 1. P-E10 [19.0 ± 3.8], P-B [1.21 ± 0.22], and P-DIV10 [36.8 ± 9.8]. Sharpe Ratios are calculated as the mean return on the portfolio minus the mean return on 30-day Treasuries (0.71%) divided by the standard deviation of portfolio returns. Results are based on 84 portfolio simulations created using annual returns data for the period 1926 to 2009.

deviation of returns than the static portfolio; however, all three adaptive portfolios also had higher Sharpe Ratios than the static portfolio, indicating that the moderate increases in volatility were more than compensated for with higher returns. Stock/bond allocations other than 50/50 showed similar results.

3.3. Rates of withdrawal and asset allocations for 30-year retirement portfolios

Two primary concerns for someone beginning retirement are the probability of running out of money (shortfall risk) and the amount of money (legacy) remaining upon reaching one's life expectancy. Addressing either or both concerns depends on one's withdrawal rate. Studies such as Bengen (1994) and Tezel (2005) find that optimal inflation-adjusted rates of withdrawal for 30-year portfolios range between 3% and 5%. Consistent with these studies, we use annual inflation-adjusted rates of withdrawal of 3%, 4%, and 5% with each of the 20 reference portfolios. Thus, in the simulations that follow each of the four portfolio strategies will have five different initial stock/bond allocations (30/70, 40/60, 50/50, 60/40, and 70/30) with annual withdrawal rates of 3%, 4%, and 5% for each allocation within each strategy. Finally, each portfolio will start with an investment of \$100.

3.4. Simulation methods

We simulate 30-year retirement portfolios using bootstrapping and rolling period methods. Past studies such as Cooley, Hubbard, and Walz (2003) and Spitzer and Singh (2007) have found that, even with the same data set, results from rolling period and bootstrapping simulations may differ from one another. One reason for the inconsistency is that the models make different assumptions for the distribution of asset returns. Rolling period simulations inherently assume that stocks returns in a particular year are dependent on stocks returns in past years, and consequently, retain the serial correlation observed in stock returns. Bootstrapping models assume that stock returns for a particular year are independent of those in earlier years, and thus, ignore serial correlation in returns. The benefit of bootstrapping models is that they allow for larger sample simulations as compared with rolling period models. However, our adaptive strategy portfolios are created using mean-reverting valuation metrics, that is, they contain some information of future expected returns. Consequently, they retain some component of the serial correlation usually ignored in bootstrapping methods, suggesting that our study method somewhat mitigates the impact of the differing assumptions.

Using either simulation method, portfolio value at the end of year t, is calculated as:

$$P_t = P_{t-1}\,[w_{s,t}\,r_{s,t} + w_{b,t}\,r_{b,t} - k] \qquad (1)$$

where,

t = the year in retirement 1, 2, … 30;
P_0 = initial portfolio value is \$100;
$w_{s,t}$ = allocation to stocks at start of year t;
$w_{b,t}$ = allocation to bonds at start of year t, where $w_{b,t} = 1 - w_{s,t}$;
$r_{s,t}$, $r_{b,t}$ = return from stocks, bonds respectively in year t;
k = constant year-end retirement withdrawal rate, set at 3%, 4% or 5% as required.

Under the static strategy, stock/bond allocations are set at a fixed 30/70, 40/60, 50/50, 60/40, or 70/30; consequently portfolio weights $w_{s,t}$ and $w_{b,t}$ are set to these values at the start of each year t. For the adaptive strategies, portfolio allocations in year t depend on the value of the stock valuation metric at the start of that year. If the valuation metric at that time is within half a standard deviation of its historical average, we use the baseline 30/70, 40/60, 50/50, 60/40, or 70/30 weights (comparable with the same static allocations); if the stock valuation metric is above (below) this range, 25% is added to (deducted from) the baseline stock allocation to reflect the overvaluation (undervaluation). This implies that for any baseline portfolio allocation, there are only three possible adaptive allocations, depending on the valuation metric at the start of the year. For example, for a baseline allocation of 50/50 stocks/bonds, the only three allocations possible are 25/75, 50/50, and 75/25 stocks/bonds. These allocation criteria are used in both simulation methods.

The key difference between the rolling period and bootstrapping models is how they select asset returns and valuation metrics for a particular year *t* in retirement.

- ROLLING PERIOD simulation method: For each strategy, we generate 55 iterations of 30-year retirement portfolios created at the start of 1926 through to the start of 1980. Stock/bond returns and valuation metrics correspond to the return *t* years after date T that the retirement portfolio is created, where T = [1926 through 1980]. For example, for portfolios created at the start of 1926, stock returns in the 15th year in retirement $r_{s,15}$, correspond to the stock returns in 1940; similarly, the P-E10 ratio is the number calculated at the start of 1940.
- BOOTSTRAPPING simulation method: For each strategy, we perform 10,000 iterations of 30-year portfolios, where the annual returns and valuation metrics in year *t* correspond to those for a year generated randomly from our entire sample period [1926, 2009]. For example, the randomly generated seventh year for a particular iteration may be 1940, so $r_{s,7}$ would equal the stock returns in 1940 and the P-DIV10 ratio would be the start of year 1940 value.

4. Results

Table 3 displays the results of rolling period simulations of the three assumed withdrawal rates applied to each of the twenty reference portfolios. In interpreting the results, a static portfolio with a particular baseline allocation and withdrawal rate (e.g., 30/70 stocks/bonds with a 3% withdrawal rate) should only be compared to an adaptive P-E10, P-B, or P-DIV10 portfolio with the same baseline allocation and withdrawal rate (e.g., 30/70 stocks/bonds with a 3% withdrawal rate).

Across the 20 reference portfolios, we show the average balance remaining after 30 years and the probability of shortfall (percentage of times the portfolio's cash is depleted during a 30 year period) for each of the three withdrawal rates. For example, consider two investors each of whom expects to withdraw 5% annually. Each owns a 60/40 initial allocation stock/bond retirement portfolio, but one owns a static portfolio and the other an adaptive portfolio. The investor following the static portfolio strategy should on average expect to have a remaining balance of $99.4 after 30 years in retirement; however, there is a 30.9% probability that his portfolio will run out of money before the 30 years.[12] On the other hand, an investor owning an adaptive P-E10 portfolio strategy can expect to have a remaining balance of $221.5 (more than double her initial balance), with approximately half the probability of shortfall (16.4%).

As the allocation to stocks increases for all four portfolio strategies, the average balance remaining increases and the probability of shortfall decreases. The largest average balance remaining across all portfolio strategies and withdrawal rates is $491.2 for the 70/30 P-E10 portfolio at 3% withdrawals; the lowest balance is $27.9 for the 30/70 static portfolio at 5% withdrawals, which also has the highest probability of shortfall across all portfolios.

Table 3 Rolling period simulation method

Rolling periods method	Withdrawal rates		
	3%	4%	5%
Panel A: Static portfolio			
30/70 stocks/bonds	$115.5 (0.0%)	$61.0 (20.0%)	$27.9 (61.8%)
40/60 stocks/bonds	$150.9 (0.0%)	$88.6 (12.7%)	$45.2 (45.5%)
50/50 stocks/bonds	$192.5 (0.0%)	**$122.3 (9.1%)**	$68.8 (32.7%)
60/40 stocks/bonds	$241.0 (0.0%)	$162.7 (5.5%)	$99.4 (30.9%)
70/30 stocks/bonds	$297.0 (0.0%)	$210.1 (3.6%)	$136.7 (25.5%)
Panel B: Adaptive P-E10 portfolio			
30/70 stocks/bonds	$205.7 (0.0%)	$138.8 (9.1%)	$84.9 (29.1%)
40/60 stocks/bonds	$261.6 (0.0%)	$185.9 (3.6%)	$121.9 (23.6%)
50/50 stocks/bonds	$327.1 (0.0%)	**$242.1 (1.8%)**	$167.2 (21.8%)
60/40 stocks/bonds	$403.3 (0.0%)	$308.1 (0.0%)	$221.5 (16.4%)
70/30 stocks/bonds	$491.2 (0.0%)	$384.4 (0.0%)	$285.2 (14.6%)
Panel C: Adaptive P-B portfolio			
30/70 stocks/bonds	$178.5 (0.0%)	$115.1 (12.7%)	$66.2 (34.6%)
40/60 stocks/bonds	$228.5 (0.0%)	$156.1 (9.1%)	$98.1 (29.1%)
50/50 stocks/bonds	$287.2 (0.0%)	**$205.3 (3.6%)**	$137.2 (27.3%)
60/40 stocks/bonds	$355.6 (0.0%)	$263.6 (3.6%)	$184.8 (23.6%)
70/30 stocks/bonds	$434.6 (0.0%)	$331.2 (1.8%)	$242.5 (23.6%)
Panel D: Adaptive P-DIV10 portfolio			
30/70 stocks/bonds	$160.6 (0.0%)	$99.6 (12.7%)	$54.6 (38.2%)
40/60 stocks/bonds	$206.3 (0.0%)	$136.8 (5.5%)	$82.2 (32.7%)
50/50 stocks/bonds	$259.6 (0.0%)	**$181.7 (3.6%)**	$116.2 (29.1%)
60/40 stocks/bonds	$321.4 (0.0%)	$234.0 (1.8%)	$157.2 (25.5%)
70/30 stocks/bonds	$392.2 (0.0%)	$294.5 (0.0%)	$207.2 (20.0%)

Note: Rolling period simulation results are presented for various portfolio strategies. The adaptive portfolios are created using a 25% adaptive weight–portfolio weights change (decrease/increase) by 25% if the valuation metric (P-E10, P-B, P-DIV10) at the start of the year falls outside the range [mean ± 1/2 standard deviation]. Our study uses the following valuation metric ranges based on results from Table 1. P-E10 [19.0 ± 3.8], P-B [1.21 ± 0.22], and P-DIV10 [36.8 ± 9.8]. The dollar figures represent average balancing remaining (in real today dollars) after 30 years. The percentage figures (in parentheses) represent the probability of shortfall over 30 years. Results are based on 55 portfolio simulations created using returns data for the period 1926 to 2009.

For each stock/bond allocation and withdrawal rate, our three adaptive portfolio strategies outperform the static portfolios, on both average remaining balance and probability of portfolio shortfall. Adaptive P-E10 strategies clearly outperform all other strategies. For example, consider 50/50 stock/bond portfolios with a 4% withdrawal rate. While the average balance remaining is $122.3 with the static portfolio, it is much higher at $242.1, $205.3, and $181.7 for the P-E10, P-B, and P-DIV10 portfolios, respectively. The static portfolio has a probability of shortfall of 9.1%, while the P-E10, P-B, and P-DIV10 portfolios have probabilities of shortfall of 1.8%, 3.6%, and 3.6%, respectively.

Note that while the portfolio benefits of the adaptive strategies are apparent at all withdrawal rates and asset allocation choices, the greatest benefits are for conservative investors with higher expected withdrawal rates (risk-averse investors with low savings). For example, within the strategies outlined here, conservative investors who own 30/70 portfolios but who need to withdraw 5% every year would benefit the most from adaptive strategies. Using an adaptive P-E strategy, their average balance remaining rises to $84.9

Table 4 Bootstrapping simulation method

Bootstrapping method	Withdrawal rates		
	3%	4%	5%
Panel A: Static portfolio			
30/70 stocks/bonds	$201.9 (1.1%)	$141.7 (9.0%)	$88.6 (29.5%)
40/60 stocks/bonds	$252.9 (1.0%)	$185.9 (7.5%)	$124.9 (23.7%)
50/50 stocks/bonds	$314.2 (1.3%)	**$239.9 (7.1%)**	$171.1 (21.0%)
60/40 stocks/bonds	$387.6 (1.8%)	$305.3 (7.6%)	$228.5 (20.0%)
70/30 stocks/bonds	$475.4 (2.4%)	$384.3 (8.6%)	$298.9 (20.2%)
Panel B: Adaptive P-E10 portfolio			
30/70 stocks/bonds	$341.5 (0.7%)	$263.6 (5.6%)	$190.5 (17.5%)
40/60 stocks/bonds	$419.6 (0.7%)	$333.0 (5.0%)	$250.6 (14.6%)
50/50 stocks/bonds	$512.8 (1.1%)	**$416.6 (4.8%)**	$324.4 (13.7%)
60/40 stocks/bonds	$624.1 (1.4%)	$517.0 (5.2%)	$414.3 (13.6%)
70/30 stocks/bonds	$756.6 (2.0%)	$637.5 (6.1%)	$523.0 (14.0%)
Panel C: Adaptive P-B portfolio			
30/70 stocks/bonds	$299.9 (1.4%)	$227.5 (7.5%)	$160.6 (21.8%)
40/60 stocks/bonds	$370.0 (1.4%)	$289.5 (6.9%)	$213.9 (18.3%)
50/50 stocks/bonds	$454.0 (1.7%)	**$364.5 (6.7%)**	$279.8 (17.1%)
60/40 stocks/bonds	$554.2 (2.2%)	$454.8 (7.3%)	$360.3 (16.9%)
70/30 stocks/bonds	$673.9 (2.7%)	$563.3 (8.1%)	$458.1 (17.3%)
Panel D: Adaptive P-DIV10 portfolio			
30/70 stocks/bonds	$286.1 (1.4%)	$215.5 (8.3%)	$150.9 (23.2%)
40/60 stocks/bonds	$353.5 (1.5%)	$274.9 (7.3%)	$201.7 (19.8%)
50/50 stocks/bonds	$434.1 (1.9%)	**$346.9 (7.1%)**	$264.8 (18.2%)
60/40 stocks/bonds	$530.5 (2.3%)	$433.6 (7.5%)	$341.9 (17.7%)
70/30 stocks/bonds	$645.4 (2.9%)	$537.8 (8.4%)	$435.7 (18.0%)

Note: Bootstrapping simulation results are presented for various portfolio strategies. The adaptive portfolios are created using a 25% adaptive weight–portfolio weights change (decrease/increase) by 25% if the valuation metric (P-E10, P-B, P-DIV10) at the start of the year falls outside the range [mean ± 1/2 standard deviation]. Our study uses the following valuation metric ranges based on results from Table 1. P-E10 [19.0 ± 3.8], P-B [1.21 ± 0.22], and P-DIV10 [36.8 ± 9.8]. The dollar figures represent average balancing remaining (in real today dollars) after 30 years. The percentage figures (in parentheses) represent the probability of shortfall over 30 years. Results are based on 10,000 portfolio simulations created using returns data for the period 1926 to 2009.

from the $27.9 expected with a static portfolio, while the risk of shortfall drops to 29.1% from 61.8%.

Table 4 displays the results of bootstrapping simulations of the three assumed withdrawal rates applied to each of the 20 reference portfolios. The results are in line with those from rolling period simulations. For any portfolio strategy, the average balance remaining is positively related to stock allocation while an inverse relationship holds between shortfall probability and stock allocation. However, for the same initial target allocation, the average balance remaining is always higher and the probability of shortfall is always lower for adaptive strategies than for static strategies. For example, consider an investor with 4% withdrawals currently invested in a 50/50 stock/bond static portfolio. Moving to an adaptive P-E10 portfolio strategy with the same allocation and withdrawals, would significantly increase the expected balance remaining after 30 years to $416.6 from $239.9, while the probability that the portfolio runs out of money prematurely drops to 4.8% from 7.1%.

Table 5 Statistical mean difference tests

	Portfolio strategies			
	Static	Adaptive P-E10	Adaptive P-B	Adaptive P-DIV10
Panel A: Rolling period method				
MEAN	122.28	242.07	205.31	181.67
STDEV	110.33	184.79	166.00	142.38
N	55	55	55	55
EQUAL OR BETTER	—	100%	100%	96.4%
T-STAT	—	8.31***	7.06***	7.22***
Panel B: Bootstrapping method				
MEAN	239.87	416.57	364.46	346.86
STDEV	258.28	468.12	428.08	407.61
N	10,000	10,000	10,000	10,000
EQUAL OR BETTER	—	93.0%	83.1%	81.0%
T-STAT	—	70.79***	57.88***	55.84***

Note: Results presented are for the baseline scenario of a 50/50 stock/bond portfolio with an annual 4% withdrawal rate. The adaptive portfolios are created using a 25% adaptive weight–portfolio weights change (decrease/increase) by 25% if the valuation metric (P-E10, P-B, P-DIV10) at the start of the year falls outside the range [mean ± 1/2 standard deviation]. Our study uses the following valuation metric ranges based on results from Table 1. P-E10 [19.0 ± 3.8], P-B [1.21 ± 0.22], and P-DIV10 [36.8 ± 9.8]. MEAN and STDEV are the average and standard deviation of average balance remaining after 30 years from the *N* iterations. EQUAL OR BETTER represents the proportion of times that the adaptive strategy matches or outperforms the matched static strategy. T-STAT is the Student t statistic from the paired sample test of means of average balance remaining for the adaptive strategy versus the static strategy.

*, **, ***Indicate significance at the 5%, 1% and 0.1% level, respectively.

Consistent with the results from the rolling period simulations, the greatest beneficiaries of the adaptive strategies are risk-averse investors who require high rates of withdrawals.

We conduct additional robustness tests of the retirement portfolio strategies. For the sake of brevity, we only present results of a baseline scenario popular among finance professionals (retirement portfolios with an equal allocation to stocks and bonds and a withdrawal rate of 4%) but results for other asset allocations and withdrawal rate are similar. Table 5 lists results of statistical tests of average balance remaining for the adaptive portfolios as compared with the static portfolio. As observed in the earlier results, the adaptive P-E10 generates the highest average balance remaining, but has the largest standard deviation. This portfolio does as well or better than the static portfolio; always in the rolling period simulations, and 93% of the time in the bootstrapping simulations. Statistical tests of the P-B and P-DIV10 portfolios also indicate similar outperformance, but not to the extent of the P-E10 portfolio.

We also conduct one-tailed paired t tests of the difference in means of the adaptive portfolios versus the static portfolio. The high t -statistics from the mean difference tests (or alternately p-values less than 0.1%) indicate rejection of the null hypothesis:

> *H1: The balances remaining from a static portfolio strategy are equal to or greater than those from following a corresponding adaptive portfolio strategy.*

For portfolios matched using the same asset allocations and withdrawal rates, there is a statistically significant likelihood of the static portfolio underperforming the adaptive portfolios.

The article only presents results using adaptive weight increases or decreases of 25%. This percentage was chosen as a plausible estimate of the incremental risk-taking ability of many investors in retirement. In additional unreported tests, we find that higher adaptive weights to stock further improve the performance of retirement portfolio (increase average balances remaining and lower shortfall probabilities). Many of these higher-adaptive weight strategies would require the use of leverage or short selling, activities that must be done in margin accounts, and thus would not be allowed in QDIAs or other retirement accounts.[13]

5. Conclusion

The balance of empirical evidence indicates that, while valuation anomalies may sometimes take years to correct, eventually stock returns and valuations revert to the mean. Although a high allocation to stocks is normally the preferred option when designing sustainable retirement portfolios, the evidence in favor of mean reversion suggests that high allocations to stocks may not be appropriate when stocks are trading at much higher than normal valuations, as measured by the normalized price-earnings, price-to-book, or normalized price-dividend ratio; investors also benefit from even higher allocation to stocks when they are significantly undervalued. Using the QDIA choices available in employer-funded retirement funds as an example, we show that managers of balanced funds could add value to postretirement portfolios by employing mean-reverting valuation metrics, such as the price-earnings, the price-to-book, or the price-dividend ratio, to make allocation decisions.

The choice between a balanced fund and a target date fund is important to firms selecting QDIAs for their employees' retirement funds and to individual investors choosing between fund types and self-management. Spitzer and Singh (2008) find that, despite charging higher management fees than fixed allocation funds, target-date funds do not increase the probability of portfolio survival or increase legacy values. Our valuation-based approach to making allocation decisions for balanced funds improves significantly on the performance of Spitzer and Singh's (2008) fixed-allocation portfolios. Further, our strategies should have no affect on retirees' annual withdrawals.

Although our discussion has usually been directed toward managers of QDIAs and retirement portfolio strategies designed for QDIA-eligible portfolios, nothing precludes extension of the underlying strategies to other portfolios, including portfolios that use leverage or short selling. In addition, these low-cost allocation strategies can readily be used by individual investors either in or outside their retirement portfolios to make disciplined investment decisions.

Notes

1. Herbert Simon suggests that humans are only partially rational, and used the term "bounded rationality" to describe their decision-making, that is, they make the best decision given their limited knowledge and resources.
2. Our article does not incorporate adjustments for expense ratios or other transactions costs. Because our strategies use the lower cost investment (index funds) our results versus target date funds would only have improved had these costs been included.

3. In Spitzer and Singh (2007, 2008), and Pang and Warshawsky (2011), a "fixed" allocation fits within the Federal Register's characterization of a balanced fund, while their classifications of gently and steeply declining allocations to equity correspond closely to the Federal Register's characterization of target-date funds.
4. Many studies, such as Jegadeesh and Titman (1993) and Chan, Jegadeesh, and Lakonishok (1996), also find evidence that stock returns display "stock price momentum" (are positively serially correlated) in the short to medium term (one month to 12 months), that is, stocks that have gone up (down) recently tend to continue going up (down). However, because our study focuses on the long-duration retirement portfolios, the finding of mean reversion in long-term stock returns is more relevant.
5. While there are various explanations for a mean reverting process in stock returns, it is not our purpose to examine them here. Researchers such as Balvers and Wu (2006) suggest that the observed long-term mean reversion is a result of short-term momentum. Poterba and Summers (1988) suggest that the stationary component is because of stock prices moving away from their fundamental values; they essentially argue that mean reversion is equivalent to stationarity; short-term shocks to prices are temporary, so over the longer time prices revert to the mean. Fama and French (1988) on the other hand, argue that the stationary component in stock prices is because of mean reverting expected returns.
6. These models are discussed in detail in Bengen (1994), Cooley, Hubbard, and Walz (1998), and Spitzer and Singh (2008).
7. It is not necessary to normalize book values because earnings cyclicality is passed through to book value through retained earnings.
8. http://www.econ.yale.edu/~shiller/data/ie_data.xls.
9. Campbell and Shiller (1988, 2005) use inflation-adjusted time series data to calculate normalized earnings and normalized dividends. For ease of exposition, we use nominal figures in our calculations; we believe real figures may be significantly more informative only when dealing with high-inflation economies.
10. http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.
11. Based on summary statistics from Table 1, the valuation metric ranges used to initiate adaptive portfolio reallocations are P-E10 [19.0 ± 3.8], P-B [1.21 ± 0.22], and P-DIV10 [36.8 ± 9.8].
12. Although our results involve a different (longer) time frame, the remaining balances and probabilities of shortfall for the static strategy portfolio allocations are very close to those in Spitzer and Singh (2008).
13. Note that it is possible to for an investor indirectly to sell short or use leverage in a retirement plan by purchasing short or leveraged exchange traded funds; however, such strategies would not be allowed in a QDIA.

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