The Bucket Approach for Retirement: A Suboptimal Behavioral Trick?

Javier Estrada*
IESE Business School, Department of Finance, Av. Pearson 21, 08034 Barcelona, Spain
Tel: +34 93 253 4200, Fax: +34 93 253 4343, Email: jestrada@iese.edu

Abstract
A bucket approach, which broadly consists of parking a few years of annual withdrawals safely in cash and investing the rest of the portfolio more aggressively, is a popular strategy often recommended by financial planners and typically embraced by retirees. Although this strategy is not devoid of merit, the comprehensive evidence discussed here, from 21 countries over a 115-year period, questions its effectiveness. In fact, simple static strategies, which by definition involve periodic rebalancing, clearly outperform bucket strategies, and they do so based not just on one but on four different ways of assessing performance.

May, 2019

1. Introduction

Some individuals may have been unlucky enough to be hit by the 2008 financial storm in the early years of their retirement. Those who happened to have portfolios heavily invested in stocks may have seen their prospects for a happy retirement shattered. As is well known, bad returns in the early years of retirement may be devastating, a problem related to the issue of sequence of returns risk.

In order to avoid withdrawing funds from a portfolio that has just suffered a sharp loss, many financial planners advocate a bucket approach. This approach, which has many variations and is discussed in more detail below, essentially calls for parking safely in cash a few years of withdrawals, and investing the rest of the portfolio more aggressively. Hence, should his aggressive portfolio suffer a sharp loss, a retiree can make the annual withdrawal from the cash reserve, thus avoiding to liquidate assets at a depressed valuation.

The bucket approach is appealing for several reasons. First, it sounds plausible; there is no need to understand sequence of returns risk to realize that selling an asset just after its price has fallen sharply is usually not a good strategy. Second, it is comforting, enabling a retiree to stop worrying about the possibility of having to liquidate assets at a bad time; his near-term withdrawals are covered. Third, it is consistent with the well-known behavioral bias of mental accounting; a retiree is likely to find the separation between the withdrawal account and the

---

* I would like to thank Rosy Macedo, David Nanigian, Rob Juxon, and Jack Rader for their comments. Didac Gaznares provided valuable research assistance. IESE's Center for International Finance (CIF) kindly provided partial support for this research. The views expressed below and any errors that may remain are entirely my own.

investment account appealing. And fourth, it is easy to implement; a retiree only needs to determine his annual withdrawals for the next few years, protect those funds by parking them in safe and liquid assets, and invest the rest in more aggressive assets.

However, a plausible strategy is not necessarily an optimal one. In fact, Kitces (2014) suggests that simple static allocations yield better results than bucket strategies, unless the latter involve rebalancing. More precisely, based on U.S. evidence beginning in 1966, he shows that bucketing with rebalancing yields the same performance as static strategies, and bucketing without rebalancing underperforms static strategies.

Following up from that result, this article ultimately seeks to answer two questions. First, how did bucket strategies perform relative to static strategies in the U.S., considering a much longer (115-year) period? And second, how did bucket strategies perform relative to static strategies globally, across 21 countries, over the same long period?

In order to answer these questions, this article considers a comprehensive sample of 21 countries over the 115-year period between 1900 and 2014; it also considers 11 static strategies and three variations of the bucket strategy. Ultimately, the evidence shows that a bucket approach underperforms static strategies, and it does so based on four different ways of assessing performance. For this reason, however plausible, comforting, consisting with mental accounting, and easy to implement the bucket approach may be, simple static strategies, which call for periodic rebalancing and are just as easy to implement, would make retirees better off.

Although the bucket approach seems to be popular with practitioners, it has received very little attention from academics; hence, little is known about the pros and cons of this strategy relative to other retirement strategies. This article aims to fill that void. To that purpose, section 2 tackles in more depth the issue at stake, including both a more detailed discussion of the bucket approach and the performance measures used to evaluate retirement strategies. Section 3 introduces the 11 static strategies and the three variations of the bucket approach considered, and discusses the evidence on them based on the comprehensive sample used here. Finally, section 4 provides an assessment. An appendix with tables concludes the article.

2. The Issue

This section first discusses some general aspects of the bucket approach for retirement, leaving the specific rules considered here for the next section. Then it briefly discusses some variables used to evaluate the performance of retirement strategies, beginning with the failure rate and continuing with other alternatives. And finally, it discusses more in depth the four variables used here to assess the relative performance of bucket strategies and static strategies.

2.1. The Bucket Approach

A bucket strategy is a broad scheme that involves parking safely in cash a few years of withdrawals, and investing the rest of the portfolio more aggressively. The purpose of the cash reserve is to provide a retiree with funds for withdrawals should his more aggressive portfolio suffer a sharp loss. Credit for pioneering this scheme is usually given to financial planner Harold Evensky. Christine Benz from Morningstar has written extensively on the subject and is a well-known supporter of the approach; see, for example, Benz (2016), and many of her articles on Morningstar's website.

The number of buckets and the number of years of withdrawals parked in cash varies across practitioners. The most popular choices seem to be using two or three buckets, and parking one to five years of withdrawals in cash. In the case of two buckets, typically one is for cash (often referred to as Bucket 1) and the other for stocks and bonds (Bucket 2); in the case of three buckets, usually one is for cash (Bucket 1), another for investment-grade, medium-term bonds (Bucket 2), and another for stocks and other relatively riskier assets (Bucket 3). The years of withdrawals parked in cash tends to be related to the number of buckets; financial planners that recommend using two (three) buckets tend to recommend more (fewer) years of withdrawals safely set aside in Bucket 1.

Bucket strategies also need a rule that determines how the buckets are going to be refilled over time. Consider the case of a retiree that aims to keep (say) three years of withdrawals safely parked in cash. In the case of two buckets, Bucket 2 will necessarily get depleted over time, because of annual withdrawals or refills of Bucket 1. In the case of three buckets, the retiree needs to decide whether to keep a fixed number of annual withdrawals in Bucket 2, or to keep the *proportion* between Bucket 2 and Bucket 3 constant over time through periodic rebalancing.

Importantly, note that largely by definition, a bucket approach and periodic rebalancing are inconsistent with each other. This is the case because as long as a retiree aims to keep a fixed *number* of annual withdrawals parked in cash, the proportion between Bucket 1 and the rest of the portfolio (Bucket 2, or Buckets 2 and 3) will tend to increase over time as funds in the former are kept constant and funds in the latter decrease (due to withdrawals or refills of Bucket 1). For this reason, a retiree can decide, at most, to keep a constant proportion between Buckets 2 and 3 (but not between Bucket 1 and the rest of the portfolio) through periodic rebalancing.

A caveat is in order. Given that the bucket approach is a general idea whose precise implementation needs to be outlined, a retiree may presumably decide that his bucket strategy would consist of fixed *proportions* of Bucket 1 and Bucket 2, such as 20% in Bucket 1 and 80% in Bucket 2. Although possible in principle, this rule would run counter to one of the basic tenets of the bucket approach, which is to keep a fixed *number* of annual withdrawals safely parked in cash.

Obviously, 20% of a fluctuating (and trend-wise decreasing) portfolio does not guarantee the availability of a fixed number of annual withdrawals. End of caveat.

In order to make a direct comparison between bucket strategies and static strategies, the bucket rules discussed in the next section and evaluated in this article involve two buckets, the first with a fixed number of annual withdrawals. This approach rules out rebalancing to keep the proportion between Buckets 1 and 2 constant over time. Furthermore, this approach enables a more direct evaluation of Kitces' (2014) contention that bucketing without rebalancing underperforms static asset allocations, which by definition do involve periodic rebalancing.

2.2. The Evaluation of Retirement Strategies

Beginning with the pioneering article by Bengen (1994), the failure rate has become the variable most widely used to evaluate retirement strategies. This variable aims to proxy for the probability of failure and measures how often a strategy failed to sustain a withdrawal plan, thus depleting a portfolio before a retiree's death, over the (historical or simulated) retirement periods evaluated.

Regardless of its widespread use and undisputable usefulness, the failure rate has several limitations; Milevsky (2016) discusses this issue in some depth. For this reason, some alternative definitions of failure have been proposed; these include the probability of not reaching the goal set for different mental account subportfolios (Das et al, 2010) and the probability of not reaching an individual's personal goals (Brunel, 2015, and Parker, 2016), among others.

Furthermore, alternative variables that aim to capture other important features of retirement strategies not captured by the failure rate have also been proposed. These include the success-to-variability ratio (Blanchett, 2007) and the perfect withdrawal amount (Suarez et al, 2015, and Clare et al, 2017).[1] They also include three variables proposed recently, namely, shortfall years, risk-adjusted success, and downside risk-adjusted success (Estrada, 2017, 2018*a*, and 2018*c*), which are discussed in more detail below.

2.3. Four Evaluation Variables

The first of the four variables used in this article to evaluate the relative performance of bucket strategies and static strategies is the ubiquitous failure rate. Formally, let f be a variable that takes a value of 1 in a retirement period in which a strategy failed and 0 otherwise; then, the *failure rate* (F) is defined as

$$F = \left(\frac{1}{T}\right) \cdot \sum_{t=1}^{T} f_t \qquad (1)$$

[1] On very closely-related variables, see, also, Blanchett et al (2012) on the sustainable spending rate, and Miller (2016) and Estrada (2018*b*) on the maximum withdrawal rate.

where T is the number of (historical or simulated) retirement periods evaluated and t indexes retirement periods, both typically measured in years.

The second variable is shortfall years, which aims to complement the failure rate by measuring the average number of years a strategy failed to support withdrawals, over all the retirement periods in which it failed; see Estrada (2017). Formally, let L be the length of the retirement period considered, and N_t the number of years a strategy fell short from L in retirement period t; thus, *shortfall years* (S_Y) is defined as

$$S_Y = \frac{\sum_{t=1}^{T} f_t \cdot N_t}{\sum_{t=1}^{T} f_t} \tag{2}$$

where the numerator is the total number of years a strategy fell short from L over all the retirement periods in which it failed, and the denominator is the number of retirement periods in which the strategy failed. The aim of shortfall years is to complement the failure rate, which measures *how often* a strategy failed, by measuring *by how much* (on average) it failed.

The third variable is risk-adjusted success, or RAS, which is the ratio between the expected value and the standard deviation of the variable years sustained. This last variable aims to capture the average number of years a strategy sustained withdrawals *both* in failure and in success; see Estrada (2018*a*). Formally, let years sustained (Y_S) take two values, one over the retirement periods in which a strategy failed ($Y_{S\text{-}F}$), and another over the retirement periods in which it succeeded ($Y_{S\text{-}S}$); that is,

$$\begin{aligned} Y_S = Y_{S\text{-}F} &= \frac{\sum_{t=1}^{T} f_t \cdot (L-N_t)}{\sum_{t=1}^{T} f_t} = L - S_Y \qquad \text{when the strategy failed} \\ = Y_{S\text{-}S} &= \frac{\sum_{t=1}^{T} g_t \cdot (L+B_t)}{\sum_{t=1}^{T} g_t} = L + B_Y \qquad \text{when the strategy succeeded} \end{aligned} \tag{3}$$

where g is a variable that takes a value of 1 in a retirement period in which a strategy succeeded and 0 otherwise (hence, by definition, $g_t = 1 - f_t$); B_t is the bequest left in the periods in which a strategy succeeded; and B_Y is the average bequest over those periods, expressed in years of inflation-adjusted withdrawals. In words, over all the periods in which a strategy failed, it still sustained (on average) $L-S_Y$ years of withdrawals; over all the periods in which the strategy succeeded, in turn, it sustained L years of withdrawals during the retiree's lifetime and left behind a mean bequest B_Y (expressed in years of real withdrawals).

Given that the failure rate is a proxy for the probability of failure, which implies that a strategy fails with probability F and succeeds with probability $1-F$, then the expected value (E) and standard deviation (SD) of Y_S are respectively given by

$$\mathrm{E}(Y_S) = F\cdot(L-S_Y) + (1-F)\cdot(L+B_Y) \quad (4)$$

$$\mathrm{SD}(Y_S) = \{F\cdot[(L-S_Y)-\mathrm{E}(Y_S)]^2 + (1-F)\cdot[(L+B_Y)-\mathrm{E}(Y_S)]^2\}^{1/2} \quad (5)$$

The ratio between the expected value and the standard deviation of Y_S yields the variable *risk-adjusted success* (RAS), which is formally given by

$$\mathrm{RAS} = \mathrm{E}(Y_S) \,/\, \mathrm{SD}(Y_S) \quad (6)$$

Note that, when evaluating two strategies, that with a higher RAS is the one that had superior performance; this is the case because a higher RAS indicates more years of withdrawals sustained or less variability in the years of withdrawals sustained.

Finally, the fourth variable is downside risk-adjusted success, or D-RAS, which tweaks the denominator of RAS to account only for the downside variability of years sustained; see Estrada (2018*c*). Formally, the semideviation of Y_S with respect to the length of the retirement period (SSD_L) is given by

$$\mathrm{SSD}_L(Y_S) = \{\, F\cdot(-S_Y)^2 \,\}^{1/2} = (F^{1/2})\cdot S_Y \quad (7)$$

Therefore, *downside risk-adjusted success* (D-RAS) is given by the ratio between the expected value of Y_S and its semideviation with respect to L; that is,

$$\text{D-RAS} = \mathrm{E}(Y_S) \,/\, \mathrm{SSD}_L(Y_S) \quad (8)$$

Note that, when evaluating two strategies, that with a higher D-RAS is the one that had superior performance. This is the case because a higher D-RAS indicates more years of withdrawals sustained or less variability in the years of withdrawals sustained during retirement periods in which a strategy failed.[2]

The key difference between RAS and D-RAS is that the former penalizes very large bequests (large departures above the mean) whereas the latter does not; in fact, D-RAS only penalizes strategies in those retirement periods in which they fail, and it does so according to the size of the shortfall. Put differently, the difference between RAS and D-RAS is somewhat similar to the difference between a Sharpe ratio, which penalizes volatility regardless of whether fluctuations are above or below the mean, and a Sortino ratio, which penalizes only fluctuations below a chosen benchmark.

[2] The semideviation measures volatility below, but not above, a chosen benchmark. Since the benchmark chosen here is the length of the retirement period (30 years), then SSD_L measures the variability in years of withdrawals sustained over all the periods in which a strategy failed.

3. Evidence

This section discusses the global evidence on the bucket approach based on 21 countries over the 115 years between 1900 and 2014. The first part discusses the data and methodology; the second part discusses 11 static strategies, three bucket strategies, and their performance; and the third part discusses some variations of the three bucket strategies considered here.

3.1. Data and Methodology

The sample considered is the Dimson-Marsh-Staunton database, described in detail in Dimson, Marsh, and Staunton (2002, 2016). It contains annual returns for stocks and short-term government bonds (bills) over the 1900-2014 period for 21 countries. Returns are real (adjusted by each country's inflation rate), in local currency, and account for both capital gains/losses and cash flows (dividends or coupons). Exhibit A1 in the appendix summarizes some characteristics of all the series of stock and bond returns in the sample.

The analysis is based on a $1,000 portfolio at the beginning of retirement, a 4% initial withdrawal rate (IWR), annual withdrawals made at the beginning of each year, and a 30-year retirement period. As is standard in the literature, the IWR indicates the proportion of the portfolio that is withdrawn at the beginning of retirement, with the subsequent annual withdrawals adjusted by inflation.

The annual withdrawals are taken proportionally from stocks and bills when implementing static strategies, and from one of the two buckets (depending on each specific rule) when implementing bucket strategies. After the withdrawal is made, in the case of static strategies the portfolio is rebalanced to the target asset allocation; in the case of bucket strategies, no rebalancing takes place. After the annual withdrawal is made and the allocation is rebalanced (when it applies), the portfolio compounds at the observed return of stocks and bills for the year.

This process is repeated at the beginning of each year during the 30-year retirement period, which leads to two possible outcomes: either the portfolio fails along the way (that is, it gets depleted before the end of the retirement period) or it leaves a bequest. The first 30-year retirement period considered is 1900-1929 and the last one is 1985-2014, for a total of 86 rolling (overlapping) periods.

3.2. Strategies and Performance

The analysis considers 11 static strategies and three bucket strategies. The 11 static strategies differ on their fixed allocation to stocks and bills, ranging between 100 (all stocks) and 0 (no stocks), with nine allocations (90, 80, …, 20, 10) in between, in all cases indicated by the proportion of stocks in the portfolio; the rest is allocated to bills.

The three bucket strategies consist of two buckets, one with funds parked in bills (Bucket 1) and the other with funds invested in stocks (Bucket 2). All three strategies set aside two years worth of inflation-adjusted withdrawals and park them in bills, investing the rest in stocks. Also, all three strategies determine whether to make the annual withdrawal from Bucket 1 or Bucket 2, and whether to refill Bucket 1 when it has less than two years of real withdrawals, depending on the performance of the stock market; the specific rules are outlined in Exhibit 1.

Exhibit 1: Bucket Strategies

This exhibit outlines three bucket strategies. In all cases Bucket 1 refers to funds parked in bills and Bucket 2 to funds invested in stocks. Whether the annual withdrawal is taken from Bucket 1 or Bucket 2 depends on the performance of the stock market, with R_1 being its return over the previous year; R_5 being its geometric mean return over the previous five years; and R_{LT} being its long-term geometric mean return.

Bucket rule 1 (BR-1)	If $R_1 > 0$	Withdraw from Bucket 2 and refill Bucket 1 (if needed)
	If $R_1 < 0$	Withdraw from Bucket 1
Bucket rule 2 (BR-2)	If $R_1 > R_{LT}$	Withdraw from Bucket 2 and refill Bucket 1 (if needed)
	If $R_1 < R_{LT}$	Withdraw from Bucket 1
Bucket rule 3 (BR-3)	If $R_5 > R_{LT}$	Withdraw from Bucket 2 and refill Bucket 1 (if needed)
	If $R_5 < R_{LT}$	Withdraw from Bucket 1

The three bucket rules aim to avoid withdrawing funds from Bucket 2 after stocks have performed badly, but differ in how they assess the performance of stocks, and particularly in how they define a bad performance. Bucket rule 1 (BR-1) focuses on the return of stocks over the previous year (R_1); bucket rule 2 (BR-2) compares the return of stocks over the previous year to their long-term geometric mean return (R_{LT});[3] and bucket rule 3 (BR-3) compares the geometric mean return of stocks over the previous five years (R_5) to their long-term geometric mean return. As already mentioned, in all cases returns are real; that is, adjusted by inflation.

BR-1 simply seeks to avoid withdrawing from stocks after they have gone down the previous year; it is obviously easy to implement and among the most popular bucket rules recommended by financial planners. Note that BR-1 leads to withdrawing funds from Bucket 2 as long as the return of stocks over the previous year is positive, however low. BR-2, on the other hand, leads to withdrawing funds from Bucket 2 only when the return of stocks over the previous year was higher than their long-term mean return. Given that in all markets the long-term mean return of stocks is positive, then BR-2 tends to withdraw from Bucket 2 less often than BR-1 does.

Finally, BR-3 takes a somewhat different approach by comparing stock returns over the previous five years to their long-term return. It is based on the idea of mean reversion, which tends to be strong over five-year periods, as suggested in the seminal work of Fama and French (1988) and Poterba and Summers (1988). This rule aims to avoid withdrawing funds from Bucket 2 after a run of low stock returns (relative to their long-term performance) that is expected to

[3] R_{LT} is the geometric mean return between the beginning of 1900 and the point at which a withdrawal decision is made. For this reason, it keeps adding one observation as each year goes by.

mean revert in the near future. Conversely, it aims to withdraw funds from Bucket 2 after a strong five-year performance (again relative to their historical performance) that is also expected to mean revert in the near future.[4]

Exhibit 2 summarizes the evidence on the 11 static strategies and the 3 bucket strategies considered, for the U.S. market over the 115-year period between 1900 and 2014. It reports the failure rate, shortfall years, risk-adjusted success, and downside risk-adjusted success; Exhibits A2 and A3 in the appendix report the same information for the rest of the countries in the sample. In all three exhibits, the numbers highlighted indicate the lowest failure rate and shortfall years, and the highest RAS and D-RAS, across static strategies on the one hand and bucket strategies on the other.

Exhibit 2: Static Strategies vs. Bucket Strategies – USA

This exhibit shows the performance of static strategies (panel A) and bucket strategies (panel B) for the U.S. market, as summarized by the failure rate (F), shortfall years (S_Y), risk-adjusted success (RAS), and downside risk-adjusted success (D-RAS), as defined in expressions (1), (2), (6), and (8) in the text, over 86 rolling 30-year retirement periods, beginning with 1900-29 and ending with 1985-2014. The 11 static strategies range between 100 (all stocks) and 0 (no stocks), with nine allocations (90, 80, ..., 20, 10) in between, in all cases indicated by the proportion of stocks in the portfolio (the rest being allocated to bills). The three bucket strategies (BR-1, BR-2, and BR-3) are those outlined in Exhibit 1. All strategies are based on a starting capital of $1,000, a 4% initial withdrawal rate, subsequent annual withdrawals adjusted by inflation, and annual rebalancing when it applies. F is expressed in % and S_Y in years. The data is described in Exhibit A1.

Panel A	F	S_Y	RAS	D-RAS
100	3.5	5.7	6.7	104.5
90	2.3	5.0	8.8	125.7
80	2.3	2.5	9.7	217.3
70	1.2	1.0	15.5	663.1
60	0.0	N/A	N/A	N/A
50	1.2	1.0	20.2	493.8
40	3.5	2.3	13.2	105.8
30	12.8	3.5	7.7	31.6
20	25.6	4.6	6.1	15.2
10	43.0	5.0	5.8	9.6
0	67.4	5.4	5.8	6.3
Panel B				
BR-1	4.7	5.8	6.0	80.5
BR-2	3.5	5.3	6.9	102.5
BR-3	4.7	3.3	6.1	149.6

Several results are worth noticing from Exhibit 2. First, as panel B shows, BR-2 and BR-3 outperform BR-1 in the sense of having a lower F and S_Y, and a higher RAS and D-RAS. Thus, BR-1, the simplest and perhaps most popular bucket rule is outperformed by bucket strategies that take a longer perspective of stock market performance.

Second, as panel A shows, of the 11 static strategies considered, the traditional 60-40 stock-bond allocation has never failed; in fact, all strategies with at least 40% of stocks have very

[4] In all three bucket rules, when Bucket 1 does not have enough funds for the annual withdrawal, the shortage is taken from Bucket 2.

low failure rates, in all cases under 5%. Furthermore, although S_Y is meaningless for the 60-40 allocation, it is very low for allocations with 50% and 70% in stocks; in fact, when these two strategies failed, they fell short, on average, by only one year. Finally, both RAS and D-RAS have their highest values for these two allocations (the infinite value they take for the 60-40 allocation notwithstanding).[5]

Third, and perhaps most importantly, the best-performing static strategies (those with allocations to stocks between 50% and 70%), clearly outperform the best-performing bucket strategies (BR-2 and BR-3); the three static allocations have a lower *F* and S_Y, as well as a higher RAS and D-RAS. This is a first indication that, however appealing bucket strategies may be, retirees would be better off adopting static strategies, which are just as easy to implement. Importantly, this conclusion is based not on just one but on *four* different ways of assessing performance.

Exhibits A2 and A3 in the appendix report results for the rest of the countries in the sample; Exhibit 3 here reports the cross-sectional averages across all those countries (and the U.S). Although the results obviously vary across countries, those for the 'average country' in the sample largely confirm and strengthen those already discussed for the U.S.

Exhibit 3: Static Strategies vs. Bucket Strategies – Cross-Sectional Averages
This exhibit shows the performance of static strategies (panel A) and bucket strategies (panel B) for average market in the sample, as summarized by the failure rate (*F*), shortfall years (S_Y), risk-adjusted success (RAS), and downside risk-adjusted success (D-RAS), as defined in expressions (1), (2), (6), and (8) in the text, over 86 rolling 30-year retirement periods, beginning with 1900-29 and ending with 1985-2014. The 11 static strategies range between 100 (all stocks) and 0 (no stocks), with nine allocations (90, 80, …, 20, 10) in between, in all cases indicated by the proportion of stocks in the portfolio (the rest being allocated to bills). The three bucket strategies (BR-1, BR-2, and BR-3) are those outlined in Exhibit 1. All strategies are based on a starting capital of $1,000, a 4% initial withdrawal rate, subsequent annual withdrawals adjusted by inflation, and annual rebalancing when it applies. *F* is expressed in % and S_Y in years. The data is described in Exhibit A1.

Panel A	*F*	S_Y	RAS	D-RAS
100	27.8	8.9	3.4	50.7
90	28.1	8.4	3.2	40.5
80	28.5	8.0	3.2	42.0
70	29.0	7.9	3.6	59.9
60	30.7	7.5	3.4	50.8
50	33.5	7.6	4.6	69.5
40	36.4	8.0	4.0	24.0
30	40.7	8.4	3.6	13.3
20	47.9	8.5	3.4	9.0
10	57.9	8.8	3.4	6.2
0	66.9	9.3	3.6	4.5
Panel B				
BR-1	31.6	8.7	3.8	36.4
BR-2	31.6	8.5	3.9	38.6
BR-3	30.1	8.0	2.8	51.1

[5] Note that when a strategy never failed (*F*=0), the calculation of the average shortfall *in failing periods* (S_Y) is rendered meaningless. Furthermore, note from expressions (4) through (8) that when *F*=0, then SD(Y_S)=SSD$_L$(Y_S)=0, and both RAS and D-RAS tend to infinity. This explains the three 'N/A' in the exhibit.

More precisely, among bucket strategies, BR-2 and BR-3 outperform BR-1; and BR-3 outperforms BR-2 according to three of the four evaluation variables used here (F, S_Y, and D-RAS). Among static strategies, allocations to stocks between 50% and 60% outperform the rest of the allocations in terms of three variables (S_Y, RAS, and D-RAS); a portfolio fully invested in stocks, on the other hand, outperforms all other allocations in terms of the remaining variable (F), although the decrease in failures is not substantial relative to a 60-40 stock-bond allocation.[6] More importantly, static strategies again outperform bucket strategies for the average country in the sample. A balanced (50-50) strategy, in particular, displays a lower S_Y, and a higher RAS and D-RAS, than BR-2 and BR-3, albeit with a slightly higher failure rate.

In short, the comprehensive evidence evaluated here validates and strengthens Kitces' (2014) contention that static strategies outperform bucket strategies. In fact, this evidence indicates that they do so not just in the U.S. and since the mid-1960s but globally and since the beginning of the previous century.

3.3. Some Extensions

As already mentioned, a bucket approach is a broad strategy that can be implemented in many different ways. In particular, the number of years of withdrawals set aside in Bucket 1 recommended by different financial planners may vary substantially, with a range from one to five years being the most popular. This begs the question of whether the results discussed in the previous section depend on the particular choice made about the number of years of withdrawals parked in bills in Bucket 1 (that is, two years).

To explore this issue further Exhibit 4 reports results, for the U.S. market and the three bucket rules discussed here (BR-1, BR-2, and BR-3), for a Bucket 1 that sets aside one, three, and five years of withdrawals. For ease of comparison, the exhibit also shows the results reported on Exhibit 2 for two years of withdrawals, as well as for static strategies with 70% and 50% allocated to stocks. The figures highlighted correspond to the lowest F and S_Y, as well as to the highest RAS and D-RAS, across the different bucket strategies considered.

Three results stand out from this exhibit. First, setting aside one year of withdrawals outperforms setting aside two, three, or five years of withdrawals for the three bucket rules discussed here. This result is clear based on three out of the four evaluation variables considered (F, RAS, and D-RAS), and somewhat less clear based on the remaining variable (S_Y). Interestingly, for all three bucket rules, setting aside five years of annual withdrawals causes the failure rate to increase dramatically, from under 10% to over 25%.

[6] The difference in failure rates between the portfolios allocated 100% and 60% to stocks is in fact very small, less than three percentage points, and amounts to only two additional failures.

Exhibit 4: Static Strategies vs. Bucket Strategies – Sensitivity Analysis – USA

This exhibit shows the performance of two static strategies (panel A) and three bucket strategies (panels B through D) for the U.S. market, as summarized by the failure rate (F), shortfall years (S_Y), risk-adjusted success (RAS), and downside risk-adjusted success (D-RAS), as defined in expressions (1), (2), (6), and (8) in the text, over 86 rolling 30-year retirement periods, beginning with 1900-29 and ending with 1985-2014. The two static strategies allocate 70% (70) and 50% (50) to stocks, the rest being allocated to bills. The three bucket strategies (BR-1, BR-2, and BR-3) are those outlined in Exhibit 1. The number of years indicated in the first column correspond to the number of annual withdrawals set aside in Bucket 1. All strategies are based on a starting capital of $1,000, a 4% initial withdrawal rate, and subsequent annual withdrawals adjusted by inflation. F is expressed in % and S_Y in years. The data is described in Exhibit A1.

	F	S_Y	RAS	D-RAS
Panel A: Static				
70	1.2	1.0	15.5	663.1
50	1.2	1.0	20.2	493.8
Panel B: BR-1				
2 Years	4.7	5.8	6.0	80.5
1 Year	2.3	6.0	8.3	121.8
3 Years	9.3	6.3	4.3	46.1
5 Years	27.9	6.0	2.5	20.3
Panel C: BR-2				
2 Years	3.5	5.3	6.9	102.5
1 Year	2.3	4.5	8.4	165.0
3 Years	7.0	6.0	5.0	57.3
5 Years	25.6	5.1	2.7	26.3
Panel D: BR-3				
2 Years	4.7	3.3	6.1	149.6
1 Year	1.2	4.0	11.9	265.3
3 Years	7.0	4.7	5.0	76.1
5 Years	25.6	5.5	2.6	26.0

Second, again BR-2 and BR-3 outperform BR-1, and BR-3 tends to outperform BR-2. In other words, the simplest and most popular bucket rule, based on the performance of stocks over the previous year, is outperformed by rules that take a longer-term perspective of stock market performance. In particular, this evidence suggests that the best results are obtained when assessing stock market performance based on five-year mean reversion.

Third, and perhaps most importantly, even the best-performing bucket rule, BR-3 with one year of withdrawals set aside in Bucket 1, underperforms static strategies with an allocation to equity of 70% and 50%. This result reinforces, once again, the contention that static strategies outperform bucket strategies.

Why is this case? Most implementations of the bucket approach, and clearly the most popular versions that involve parking in bills a fixed *number* of annual withdrawals, distribute funds from more aggressive buckets into more conservative buckets, *but not the other way around*. Put differently, although bucket strategies avoid selling low by withdrawing from Bucket 1 after stocks performed badly, *they do not take advantage of also buying low* as static strategies do through rebalancing. Static strategies sell assets that have become relatively more expensive *and* buy assets that have become relatively cheaper, thus enhancing the performance of the overall portfolio.

4. Assessment

There is little question that a strategy that guarantees the availability of funds for the next few years of withdrawals is attractive on many levels. A retiree following the bucket approach neither needs to worry about having to sell assets that have gone down substantially in order to satisfy his withdrawal needs, nor does he need to make complicated calculations to implement the strategy. And yet the results discussed here, for a comprehensive sample of 21 countries over a 115-year period, clearly suggest that retirees would be better off following static strategies. This begs the obvious question: Why are bucket strategies so popular?

One possibility is lack of information. As already mentioned, although bucket strategies are popular among retirees and financial planners, they have received little attention from academics, resulting in a void of evidence assessing their performance relative to static strategies. This article will hopefully help to fill this void.

Another possibility is simply that retirees 'feel good' implementing bucket strategies. As already mentioned, bucket strategies sound plausible, enable retirees to stop worrying about their short-term withdrawal needs, and they are easy to implement. This, however, should not ignore the evidence, such as that discussed in this article, showing the underperformance of these strategies relative to static strategies.

A third possibility is that bucket strategies are consistent with the behavioral bias of mental accounting which, as is well known, is on the one hand widespread and on the other largely detrimental. Just as some individuals have excess cash in their current account and credit card debt at the same time, simply because these two accounts are separated in their mind, they may also find it appealing to mentally separate their withdrawal account from their investment account. That is essentially what a bucket strategy does.

These three possibilities do not exclude each other and may all help to explain the popularity of the bucket approach. However, the evidence discussed here runs counter to the superficial appeal of this approach. Most bucket strategies, and certainly those that park in bills a fixed number of annual withdrawals, avoid selling underperforming assets but refrain from buying more of those assets when their price goes down. Static strategies, which by definition imply periodic rebalancing, actively sell assets that have become relatively more expensive, and critically, also buy assets that have become relatively cheaper, thus enhancing performance.

In short, the results discussed here suggest that financial planners should strive to explain to clients the benefits of static strategies relative to those of bucket strategies. They should explain that satisfying the behavioral need of mental accounting imposes a cost in terms of performance. And they should attempt to convince retirees that however plausible, comforting, and easy to implement the bucket approach may be, a static strategy with an appropriate asset allocation would be just as easy to implement and would ultimately make them better off.

Appendix

Exhibit A1: Summary Statistics

This exhibit shows, for the series of annual returns over the 1900-2014 period, the arithmetic (AM) and geometric (GM) mean return, standard deviation (SD), semideviation for a 0% benchmark (SSD), lowest return (Min), and highest return (Max). All returns are real (adjusted by each country's inflation rate), in local currency, and account for capital gains/losses and cash flows (dividends or coupons). All figures in %.

	AM	GM	SD	SSD	Min	Max
A: Stocks						
Australia	8.9	7.3	17.9	9.2	−42.5	51.5
Austria	4.6	0.6	30.0	15.6	−60.1	127.1
Belgium	5.4	2.7	23.7	13.0	−48.9	105.1
Canada	7.2	5.8	16.9	8.4	−33.8	55.2
Denmark	7.2	5.3	20.7	8.9	−49.2	107.8
Finland	9.3	5.3	30.0	13.9	−60.8	161.7
France	5.7	3.2	23.1	12.3	−41.5	66.1
Germany	8.2	3.2	31.7	14.7	−90.8	154.6
Ireland	6.8	4.2	22.9	11.9	−65.4	68.4
Italy	5.9	1.9	28.5	15.6	−72.9	120.7
Japan	8.8	4.1	29.6	15.2	−85.5	121.1
Netherlands	7.1	5.0	21.4	10.3	−50.4	101.6
New Zealand	7.8	6.1	19.4	9.0	−54.7	105.3
Norway	7.2	4.2	26.9	11.7	−53.6	166.9
Portugal	8.4	3.4	34.4	15.3	−76.6	151.8
South Africa	9.5	7.4	22.1	9.0	−52.2	102.9
Spain	5.9	3.7	21.9	11.0	−43.3	99.4
Sweden	8.0	5.8	21.2	10.8	−42.5	67.5
Switzerland	6.3	4.5	19.5	10.1	−37.8	59.4
UK	7.1	5.3	19.6	9.7	−57.1	96.7
USA	8.5	6.5	20.0	10.4	−37.6	56.3
B: Bills						
Australia	0.8	0.7	5.3	3.4	−15.5	18.5
Austria	−3.9	−8.1	18.6	18.7	−94.2	12.6
Belgium	0.6	−0.3	12.7	9.3	−46.6	69.0
Canada	1.6	1.5	4.8	2.5	−12.5	27.1
Denmark	2.3	2.1	6.0	3.1	−15.8	25.1
Finland	0.5	−0.5	11.6	10.3	−69.2	19.9
France	−2.3	−2.8	9.4	8.7	−38.5	29.7
Germany	−0.4	−2.3	13.0	11.9	−91.9	38.8
Ireland	0.9	0.7	6.5	3.7	−15.5	42.2
Italy	−2.5	−3.5	11.3	11.1	−76.6	14.2
Japan	−0.3	−1.9	13.6	12.2	−77.5	29.8
Netherlands	0.7	0.6	4.9	3.0	−12.7	19.6
New Zealand	1.8	1.7	4.6	2.0	−8.1	21.1
Norway	1.4	1.1	7.0	4.3	−25.4	31.2
Portugal	−0.5	−1.1	9.7	8.2	−41.6	23.8
South Africa	1.2	1.0	6.1	3.7	−27.8	27.3
Spain	0.5	0.3	5.7	4.3	−23.8	12.6
Sweden	2.1	1.9	6.5	3.5	−23.2	42.7
Switzerland	0.9	0.8	4.9	3.1	−16.5	25.8
UK	1.1	0.9	6.3	3.5	−15.7	43.0
USA	1.0	0.9	4.6	2.9	−15.1	20.0

Exhibit A2: Static Strategies – Global Evidence

This exhibit shows the performance of 11 static strategies as summarized by the failure rate (*F*), shortfall years (S_Y), risk-adjusted success (RAS), and downside risk-adjusted success (D-RAS), as defined in expressions (1), (2), (6), and (8) in the text, over 86 rolling 30-year retirement periods, beginning with 1900-29 and ending with 1985-2014. The 11 static strategies range between 100 (all stocks) and 0 (no stocks), with nine allocations (90, 80, …, 20, 10) in between, in all cases indicated by the proportion of stocks in the portfolio (the rest being allocated to bills). All strategies are based on a starting capital of $1,000, a 4% initial withdrawal rate, subsequent annual withdrawals adjusted by inflation, and annual rebalancing. *F* is expressed in % and S_Y in years. The data is described in Exhibit A1.

AA	100	90	80	70	60	50	40	30	20	10	0
Australia											
F	3.5	3.5	3.5	2.3	4.7	12.8	23.3	26.7	33.7	65.1	72.1
S_Y	12.0	10.0	8.3	10.0	5.0	3.6	5.0	6.7	7.4	6.3	8.1
RAS	6.0	6.2	6.6	8.4	6.9	4.6	3.6	3.6	3.6	2.9	2.9
D-RAS	67.7	67.7	67.6	57.4	67.6	46.8	21.1	12.4	8.5	6.2	4.0
Austria											
F	52.3	52.3	53.5	55.8	60.5	62.8	62.8	62.8	61.6	62.8	61.6
S_Y	14.9	15.0	15.5	15.4	15.0	15.0	15.4	15.7	16.4	16.4	17.2
RAS	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.8	1.8
D-RAS	4.0	3.7	3.3	3.1	2.9	2.7	2.5	2.3	2.0	1.9	1.7
Belgium											
F	50.0	50.0	50.0	50.0	50.0	48.8	48.8	47.7	48.8	50.0	50.0
S_Y	10.2	10.1	10.1	10.4	11.0	11.8	12.4	13.3	13.6	14.0	14.7
RAS	1.6	1.6	1.7	1.7	1.7	1.8	1.9	1.9	2.0	2.0	2.1
D-RAS	7.7	7.4	7.1	6.5	5.8	5.1	4.5	4.0	3.6	3.2	2.8
Canada											
F	1.2	0.0	0.0	0.0	0.0	1.2	2.3	8.1	17.4	22.1	32.6
S_Y	4.0	N/A	N/A	N/A	N/A	1.0	3.0	4.3	5.3	7.5	7.6
RAS	12.5	N/A	N/A	N/A	N/A	19.5	14.5	8.2	5.9	5.1	4.7
D-RAS	231.4	N/A	N/A	N/A	N/A	509.3	106.9	35.8	17.9	10.0	7.4
Denmark											
F	3.5	1.2	2.3	2.3	4.7	7.0	8.1	9.3	16.3	25.6	41.9
S_Y	4.0	5.0	3.0	2.5	2.3	3.0	3.7	4.6	4.2	4.0	3.9
RAS	7.9	13.8	10.4	10.9	8.1	6.8	6.6	6.5	5.4	4.9	4.3
D-RAS	103.5	138.8	156.4	177.5	130.5	74.0	50.8	34.8	26.1	20.1	14.3
Finland											
F	33.7	37.2	38.4	37.2	37.2	40.7	43.0	45.3	46.5	48.8	61.6
S_Y	13.0	12.6	12.9	14.0	14.8	14.5	14.6	14.8	15.2	15.3	13.1
RAS	1.6	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.8	2.0	2.2
D-RAS	15.9	14.3	12.3	10.2	8.3	6.9	5.6	4.5	3.6	2.9	2.5
France											
F	53.5	58.1	64.0	65.1	68.6	72.1	74.4	81.4	86.0	89.5	93.0
S_Y	9.0	9.4	9.5	10.0	10.1	10.3	10.8	10.6	10.9	11.6	12.2
RAS	1.5	1.4	1.3	1.4	1.4	1.5	1.7	1.8	2.1	2.6	3.5
D-RAS	8.6	7.2	6.1	5.2	4.4	3.8	3.2	2.7	2.3	1.9	1.6
Germany											
F	54.7	54.7	55.8	53.5	54.7	53.5	54.7	55.8	58.1	60.5	74.4
S_Y	13.5	13.6	13.9	14.7	14.7	15.4	15.3	15.3	15.1	14.8	12.8
RAS	1.2	1.2	1.2	1.3	1.4	1.5	1.5	1.7	1.8	2.1	2.7
D-RAS	7.8	6.8	5.8	4.9	4.3	3.6	3.2	2.8	2.4	2.2	2.0
Ireland											
F	26.7	30.2	29.1	30.2	33.7	34.9	38.4	46.5	52.3	68.6	79.1
S_Y	8.5	7.5	8.0	7.9	7.5	7.6	7.5	6.9	7.0	6.7	7.5
RAS	2.2	2.1	2.3	2.3	2.3	2.5	2.6	2.7	3.0	3.1	3.3
D-RAS	18.8	18.6	16.3	14.7	13.0	11.2	9.5	8.2	6.7	5.4	4.0
Italy											
F	60.5	66.3	67.4	70.9	73.3	76.7	79.1	81.4	87.2	90.7	94.2
S_Y	12.3	11.6	11.8	11.9	12.0	11.9	12.0	12.1	11.8	12.2	12.6
RAS	1.6	1.6	1.7	1.8	1.8	2.0	2.2	2.5	3.0	3.9	5.2
D-RAS	3.7	3.4	3.1	2.8	2.6	2.4	2.2	2.0	1.9	1.7	1.5

(*Continues*)

Exhibit A2: Static Strategies – Global Evidence (Cont.)

AA	100	90	80	70	60	50	40	30	20	10	0
Japan											
F	37.2	36.0	36.0	36.0	36.0	36.0	37.2	37.2	46.5	55.8	65.1
S_Y	13.6	13.8	13.6	13.6	13.5	13.5	13.3	13.7	11.5	11.0	10.9
RAS	1.5	1.6	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.6
D-RAS	15.8	13.2	11.2	9.4	7.9	6.8	5.7	4.8	4.4	3.7	3.0
Netherlands											
F	19.8	19.8	17.4	18.6	17.4	20.9	25.6	32.6	46.5	54.7	59.3
S_Y	7.1	5.8	5.3	4.1	3.9	4.0	4.4	5.1	5.7	7.0	8.2
RAS	2.7	2.8	3.3	3.5	4.0	4.1	4.1	4.1	3.7	3.6	3.8
D-RAS	29.7	32.3	33.1	36.4	34.5	27.1	19.8	13.2	8.8	6.0	4.4
New Zealand											
F	0.0	0.0	0.0	0.0	1.2	8.1	15.1	31.4	38.4	47.7	53.5
S_Y	N/A	N/A	N/A	N/A	1.0	1.6	2.6	3.4	5.1	6.3	7.4
RAS	N/A	N/A	N/A	N/A	16.8	6.6	5.1	3.6	3.3	3.1	3.3
D-RAS	N/A	N/A	N/A	N/A	597.2	128.7	50.5	23.8	12.8	8.2	5.9
Norway											
F	34.9	36.0	40.7	43.0	45.3	45.3	50.0	54.7	58.1	62.8	67.4
S_Y	8.8	8.1	7.2	6.9	6.5	7.0	6.8	6.9	7.5	7.9	8.7
RAS	2.0	2.0	1.9	1.9	1.9	2.0	2.0	2.1	2.2	2.4	2.6
D-RAS	12.9	13.5	13.6	13.1	12.5	10.7	9.5	8.0	6.4	5.2	4.1
Portugal											
F	46.5	44.2	41.9	38.4	43.0	45.3	51.2	54.7	70.9	76.7	82.6
S_Y	11.9	11.4	11.5	12.2	10.7	10.7	10.5	11.0	9.9	10.5	11.3
RAS	1.4	1.6	1.7	1.8	1.8	1.9	1.9	2.1	2.0	2.4	3.0
D-RAS	8.9	8.8	8.4	7.6	7.3	6.2	5.2	4.2	3.5	2.7	2.1
South Africa											
F	2.3	2.3	2.3	4.7	8.1	15.1	18.6	20.9	29.1	51.2	79.1
S_Y	3.5	3.5	4.0	3.3	4.0	4.5	5.9	7.2	6.9	6.1	6.5
RAS	7.9	8.2	8.6	6.5	5.2	4.1	4.0	4.2	4.5	4.7	4.8
D-RAS	276.1	233.4	171.5	124.7	63.7	34.8	19.8	12.7	9.5	6.9	4.5
Spain											
F	38.4	39.5	39.5	44.2	48.8	51.2	53.5	59.3	62.8	67.4	69.8
S_Y	12.1	11.4	10.9	9.7	9.0	8.8	8.7	8.2	8.3	8.5	9.1
RAS	1.8	1.9	2.0	2.0	2.0	2.2	2.3	2.5	2.7	3.0	3.4
D-RAS	7.8	7.6	7.3	7.1	6.7	6.2	5.6	5.2	4.6	4.0	3.4
Sweden											
F	24.4	19.8	17.4	16.3	15.1	14.0	14.0	14.0	24.4	43.0	52.3
S_Y	10.2	10.6	10.1	8.9	7.1	5.5	4.0	3.2	2.8	3.8	5.6
RAS	2.1	2.4	2.7	3.0	3.4	4.0	4.7	5.7	5.1	4.0	3.6
D-RAS	27.1	25.4	24.5	24.9	27.7	31.6	37.1	40.4	30.0	14.6	8.1
Switzerland											
F	31.4	30.2	30.2	29.1	25.6	32.6	34.9	40.7	51.2	68.6	75.6
S_Y	9.7	8.8	7.8	7.0	7.0	5.3	5.1	5.0	4.7	4.7	5.6
RAS	2.1	2.3	2.5	2.9	3.5	3.6	4.1	4.6	5.2	5.4	5.9
D-RAS	12.2	12.5	12.8	13.3	12.7	13.6	12.4	10.7	9.3	7.4	5.5
UK											
F	5.8	7.0	7.0	9.3	17.4	23.3	25.6	31.4	44.2	61.6	73.3
S_Y	4.0	3.0	2.8	3.0	2.6	3.2	4.1	4.7	5.1	5.5	7.0
RAS	5.5	5.3	5.6	5.1	4.0	3.7	3.8	3.9	3.7	3.6	3.4
D-RAS	100.4	110.4	104.5	75.7	56.1	34.6	22.3	15.4	10.4	7.2	4.7

Exhibit A3: Bucket Strategies – Global Evidence

This exhibit shows the performance of 3 bucket strategies as summarized by the failure rate (F), shortfall years (S_Y), risk-adjusted success (RAS), and downside risk-adjusted success (D-RAS), as defined in expressions (1), (2), (6), and (8) in the text, over 86 rolling 30-year retirement periods, beginning with 1900-29 and ending with 1985-2014. The three bucket strategies (BR-1, BR-2, and BR-3) are those outlined in Exhibit 1. All strategies are based on a starting capital of $1,000, a 4% initial withdrawal rate, and subsequent annual withdrawals adjusted by inflation. F is expressed in % and S_Y in years. The data is described in Exhibit A1.

	BR-1	BR-2	BR-3		BR-1	BR-2	BR-3		BR-1	BR-2	BR-3
Australia				*Germany*				*Portugal*			
F	3.5	3.5	3.5	F	57.0	57.0	54.7	F	51.2	51.2	48.8
S_Y	10.0	9.3	10.3	S_Y	13.1	13.1	13.2	S_Y	11.6	11.3	11.2
RAS	6.2	6.2	6.1	RAS	1.1	1.1	1.2	RAS	1.4	1.4	1.4
D-RAS	73.6	81.3	75.3	D-RAS	7.3	7.3	7.5	D-RAS	7.8	8.1	8.6
Austria				*Ireland*				*South Africa*			
F	61.6	61.6	55.8	F	31.4	32.6	32.6	F	2.3	2.3	1.2
S_Y	13.2	13.0	13.8	S_Y	7.3	7.3	7.5	S_Y	6.5	7.0	3.0
RAS	1.4	1.4	1.5	RAS	2.1	2.0	2.0	RAS	7.9	7.8	11.4
D-RAS	3.8	3.8	4.0	D-RAS	19.5	18.9	18.3	D-RAS	133.6	124.4	442.7
Belgium				*Italy*				*Spain*			
F	51.2	51.2	52.3	F	68.6	68.6	65.1	F	46.5	46.5	44.2
S_Y	9.8	9.9	9.9	S_Y	11.9	11.9	11.6	S_Y	10.3	10.6	10.8
RAS	1.6	1.6	1.5	RAS	1.6	1.6	1.6	RAS	1.7	1.7	1.7
D-RAS	7.5	7.5	7.4	D-RAS	3.2	3.2	3.6	D-RAS	7.7	7.5	7.7
Canada				*Japan*				*Sweden*			
F	1.2	1.2	0.0	F	37.2	37.2	37.2	F	24.4	24.4	22.1
S_Y	7.0	6.0	N/A	S_Y	13.6	13.6	13.5	S_Y	10.7	10.5	11.2
RAS	12.3	12.4	N/A	RAS	1.5	1.5	1.5	RAS	2.1	2.1	2.2
D-RAS	120.9	144.3	N/A	D-RAS	14.4	14.5	14.9	D-RAS	23.5	24.1	24.6
Denmark				*Netherlands*				*Switzerland*			
F	4.7	4.7	4.7	F	23.3	23.3	24.4	F	33.7	33.7	31.4
S_Y	4.0	3.8	3.0	S_Y	5.4	5.3	5.5	S_Y	10.0	9.9	9.3
RAS	7.0	7.0	7.1	RAS	2.5	2.5	2.5	RAS	2.1	2.1	2.2
D-RAS	85.4	90.8	115.8	D-RAS	33.9	34.6	31.7	D-RAS	10.5	10.6	12.1
Finland				*New Zealand*				*UK*			
F	38.4	38.4	37.2	F	1.2	1.2	0.0	F	16.3	17.4	9.3
S_Y	12.7	12.6	12.5	S_Y	0.0	0.0	N/A	S_Y	2.3	2.3	2.6
RAS	1.5	1.5	1.5	RAS	14.0	13.9	N/A	RAS	3.3	3.1	4.5
D-RAS	13.5	13.7	15.1	D-RAS	N/A	N/A	N/A	D-RAS	97.1	92.7	114.1
France				*Norway*							
F	62.8	62.8	62.8	F	41.9	41.9	39.5				
S_Y	9.1	9.1	8.6	S_Y	7.7	7.4	7.6				
RAS	1.3	1.3	1.3	RAS	1.8	1.8	1.9				
D-RAS	7.4	7.4	7.6	D-RAS	13.1	13.7	13.3				

References

Bengen, William (1994). "Determining Withdrawal Rates Using Historical Data." Journal of Financial Planning, 7, 4, 171-180.

Benz, Christine (2016). "The Bucket Approach to Retirement Allocation." Morningstar, September 19. (https://www.morningstar.com/articles/714223/the-bucket-approach-to-retirement-allocation.html)

Blanchett, David (2007). "Dynamic Allocation Strategies for Distribution Portfolios: Determining the Optimal Distribution Glide Path." Journal of Financial Planning, 20, 12, 68-81.

Blanchett, David, Maciej Kowara, and Peng Chen (2012). "Optimal Withdrawal Strategy for Retirement Income Portfolios." Retirement Management Journal, 2, 3, 7-20.

Brunel, Jean (2015). *Goals-Based Wealth Management: An Integrated and Practical Approach to Changing the Structure of Wealth Advisory Practices*. Wiley Finance.

Clare, Andrew, James Seaton, Peter Smith, and Stephen Thomas (2017). "Reducing Sequence Risk Using Trend Following and the CAPE Ratio." Financial Analysts Journal, 73, 4 (2017), 91-103.

Das, Sanjiv, Harry Markowitz, Jonathan Scheid, and Meir Statman (2010). "Portfolio Optimization with Mental Accounts." Journal of Financial and Quantitative Analysis, 45, 2, 311-334.

Dimson, Elroy, Paul Marsh, and Mike Staunton (2002). *Triumph of the Optimists – 101 Years of Investment Returns*. Princeton University Press.

Dimson, Elroy, Paul Marsh, and Mike Staunton (2016). *Credit Suisse Global Investment Returns Sourcebook 2016*. Credit Suisse Research Institute, Zurich.

Estrada, Javier (2017). "Refining the Failure Rate." Journal of Retirement, 4, 3, 63-76.

Estrada, Javier (2018*a*). "From Failure to Success: Replacing the Failure Rate." Journal of Wealth Management, Journal of Wealth Management, 20, 4, 9-21.

Estrada, Javier (2018*b*). "Maximum Withdrawal Rates: An Empirical and Global Perspective." Journal of Retirement, Journal of Retirement, 5, 3, 57-71.

Estrada, Javier (2018*c*). "Replacing the Failure Rate: A Downside Risk Perspective." Journal of Retirement, 5, 4, 46-56.

Fama, Eugene, and Kenneth French (1988). "Permanent and Temporary Components of Stock Prices." Journal of Political Economy, 96, 2, 246-273.

Kitces, Michael (2014). "Managing Sequence Of Return Risk With Bucket Strategies Vs A Total Return Rebalancing Approach" Kitces.com, November 12. (https://www.kitces.com/blog/managing-sequence-of-return-risk-with-bucket-strategies-vs-a-total-return-rebalancing-approach/)

Milevsky, Moshe (2016). "It's Time to Retire Ruin (Probabilities)." Financial Analysts Journal, 72, 2, 8-12.

Miller, Andrew (2016). "Improving Withdrawal Rates in a Low-Yield World." Journal of Financial Planning, 29, 4, 52–58.

Parker, Franklin (2016). "Goals-Based Portfolio Optimization." Journal of Wealth Management, 19, 3, 22-30.

Poterba, James, and Lawrence Summers (1988). "Mean reversion in stock prices: Evidence and Implications." Journal of Financial Economics, 22, 1, 27-59.

Suarez, Dante, Antonio Suarez, and Daniel Walz (2015). "The Perfect Withdrawal Amount: A Methodology for Creating Retirement Account Distribution Strategies." Financial Services Review, 24, 331-357.