Replacing the Failure Rate: *A Downside Risk Perspective*

JAVIER ESTRADA

JAVIER ESTRADA
is a professor of finance at IESE Business School in Barcelona, Spain.
jestrada@iese.edu

Few issues are more important for retirees than finding an appropriate strategy to manage their savings. This typically implies finding both an asset allocation and a withdrawal rate that sustain a desired level of withdrawals throughout the retirement period. A key part of dealing with this issue is to find the right variable with which to evaluate competing strategies. The failure rate, a proxy for the probability of failure, is arguably the variable most widely used for this purpose.

This failure rate, however, is not free from shortcomings. Estrada [2017] argues that two strategies may have the same failure rate and yet, when failing, they may have sustained withdrawals for a very different number of years; to overcome this flaw, he introduces a variable, shortfall years, to complement the failure rate. Furthermore, Estrada [2018] argues that two strategies may have the same failure rate and yet, when succeeding, they may have left behind very different bequests; to overcome this flaw he introduces two variables, years sustained and risk-adjusted success, the latter aiming to replace the failure rate.

The framework proposed in this article tweaks the definition of risk built into the risk-adjusted success ratio in order to incorporate a downside risk perspective. Instead of defining risk as the standard deviation of years sustained, risk is defined here as the semideviation of years sustained. This strategy leads to a new ratio, downside risk–adjusted success, or D-RAS, which is proposed as the variable to be used in the evaluation of competing retirement strategies.

Downside risk–adjusted success is applied to the selection of a single strategy, of the 11 asset allocations evaluated, for each of the 21 countries and the world market in the sample. Given the 115-year sample period considered for each country, the results discussed here provide a comprehensive evaluation of the relative performance of aggressive and conservative asset allocation strategies during retirement. Interestingly, the strategies selected by downside risk–adjusted success are both fairly different and perhaps more plausible than those selected by risk-adjusted success.

This article aims to provide financial planners with a new tool to help their clients select an optimal retirement strategy. The D-RAS ratio aims to be comprehensive enough to be used as a stand-alone tool; or, alternatively, it can also be used to provide a complementary perspective to financial planners that prefer to use other tools, such as the failure rate.

The rest of the article is organized as follows. The next section discusses in more detail the issue at stake, and particularly the D-RAS ratio introduced in this article. The section after that discusses the global evidence and the selection of the optimal strategy in each country. And the final section provides an assessment. An appendix with tables concludes the article.

THE ISSUE

This section starts with a brief overview of the issue at stake, emphasizing the intuition behind the main variables discussed in this article. It then presents the analytical framework, highlighting the years sustained variable; the two ways to assess its risk, with particular emphasis on a downside risk perspective, and the resulting D-RAS ratio. Finally, it discusses the asset allocations selected by three variables previously proposed to evaluate retirement strategies.

A Brief Overview

Stemming from the pioneering analysis by Bengen [1994], the failure rate has been the variable most widely used to evaluate competing 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 unquestionable usefulness, the failure rate has several limitations.[1]

One shortcoming of this variable is that it captures how often a strategy failed but not by how much it failed. Two strategies may have the same failure rate, but over the periods in which they failed, one may have sustained withdrawals, on average, many more years than the other. To overcome this limitation, Estrada [2017] introduces the variable shortfall years, which measures the average number of years a strategy failed to support withdrawals, over all the retirement periods in which it failed. Importantly, this variable aims to complement, rather than replace, the failure rate.

Another shortcoming of the failure rate is that it fails to account for the bequest left behind when a strategy succeeds. Two strategies may have the same failure rate, but when they succeed, one may have left, on average, a much larger bequest than the other. To overcome this limitation, Estrada [2018] proposes to change the focus from failure to success and introduces the variable *years sustained*, which measures the average number of years a strategy sustained withdrawals both when it failed and when it succeeded. The ratio between the expected value and standard deviation of years sustained yields the risk-adjusted success ratio, which aims to replace the failure rate.

Shortfall years and risk-adjusted success, however, are not free from shortcomings. The former accounts for by how much a strategy failed but not for by how often it failed. In other words, it provides some information the failure rate does not, but does not convey some information the failure rate does. For this reason, the failure rate and shortfall years should be used jointly rather than separately, in what can be referred to as the F-S_Y framework. This leads to a second shortcoming, which is that in order to select an optimal strategy, two variables need to be considered, without any assurance that they would both make the same selection. It would obviously be more convenient to be able to focus the selection process on just one variable.

Risk-adjusted success is a single variable that accounts for both the positive and negative aspects of the strategies considered. However, it measures risk with the standard deviation of years sustained, and the standard deviation penalizes deviations from the mean regardless of whether they are above or below it. For this reason, risk-adjusted success may penalize a strategy with very large deviations above the mean, such as one that left very large bequests. In other words, just like an asset with returns far above the mean can have a low Sharpe ratio due to its high volatility, a strategy that leaves high bequests may have a low risk-adjusted success ratio for the same reason.

The framework proposed in this article aims to overcome this limitation. Instead of assessing risk with the standard deviation of years sustained, risk is measured here with the semideviation of years sustained. Like any semideviation, it aims to capture *downside* volatility with respect to a chosen benchmark, thus not penalizing fluctuations above such benchmark.[2] This downside risk perspective is more aligned with the way investors assess risk, which they typically relate to "bad" scenarios (downside fluctuations) rather than to "good" ones (upside fluctuations).

[1] Milevsky [2016] discusses this issue in more depth.

[2] The semideviation with respect to a benchmark B (SSD_B) is given by $SSD_B = \{(1/T)\cdot\Sigma_t \text{Min}(R_t - B, 0)^2\}^{1/2}$, where T denotes the number of observations and R_t denotes the return in period t. For a practical introduction to the semideviation, see Estrada [2006].

D-RAS

This section introduces the analytical framework that formalizes the discussion of the previous section and the empirical discussion of the next section.[3] 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 formally defined as

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

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

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. Hence, a strategy that failed in period t still sustained $L - N_t$ years of withdrawals. Estrada [2017] defines the variable *shortfall years* (S_Y) as the average number of years a strategy fell short from L, over all the retirement periods in which it failed. Formally,

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

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.

Estrada [2018] proposes to shift the perspective from failure to success and defines the variable *years sustained* (Y_S), which can take two values, one over the retirement periods in which a strategy failed (Y_{S-F}), and another over the retirement periods in which it succeeded (Y_{S-S}). Formally,

$$Y_S = Y_{S-F} = \frac{\sum_{t=1}^{T} f_t \cdot (L - N_t)}{\sum_{t=1}^{T} f_t} = L - S_Y \quad \text{when the strategy failed}$$

$$= Y_{S-S} = \frac{\sum_{t=1}^{T} g_t \cdot (L + B_t)}{\sum_{t=1}^{T} g_t} = L + B_Y \quad \text{when the strategy succeeded} \tag{3}$$

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, expressed (not in dollars but) 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

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

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

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

$$RAS = E(Y_S)/SD(Y_S) \tag{6}$$

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 uncertainty about the years of withdrawals sustained.

The modification proposed here, building up from the framework given by Expressions (1)–(6), is to assess risk not with the standard deviation of Y_S but with its semideviation, in order to isolate volatility below, but not above, any chosen benchmark. If the benchmark chosen is $E(Y_S)$, then the semideviation with respect to the mean (SSD_E) is given by

$$SSD_E(Y_S) = \{F \cdot [(L - S_Y) - E(Y_S)]^2\}^{1/2} \tag{7}$$

One of the problems of the standard deviation, as well as of the semideviation with respect to the mean, is that given two assets with very different means, the deviations are measured with respect to two very

[3] This section borrows heavily from Estrada [2018].

different benchmarks. For this reason, when comparing semideviations, it is best to choose the same benchmark for all the assets or strategies evaluated.

This leads to the definition of risk proposed here, the semideviation of Y_S with respect to the length of the retirement period (SSD_L), which is given by

$$SSD_L(Y_S) = \{F \cdot (-S_Y)^2\}^{1/2} = (F^{1/2}) \cdot S_Y \qquad (8)$$

Three things should be highlighted about this expression. First, note that (8) is simply (7) after replacing the benchmark $E(Y_S)$ by L. Second, note that SSD_L penalizes deviations below, but not above L; in other words, SSD_L measures volatility below L. And third, note that (8) considers both how likely a strategy is to deplete a portfolio before the end of the retirement period, captured by F, and how large the shortfall will be, captured by $(L - S_Y) - L = -S_Y$.

Finally, define downside risk–adjusted success (D-RAS) as the ratio between the expected value of Y_S and its semideviation with respect to L; that is,

$$\text{D-RAS} = E(Y_S)/SSD_L(Y_S) \qquad (9)$$

Note that, when evaluating two strategies, that with a higher D-RAS is the one that had superior performance; a higher D-RAS indicates more years of withdrawals sustained or less uncertainty about the years of withdrawals sustained when falling short from the retirement period.

Some Preliminary Evidence

In order to highlight the different selections made by the failure rate (F), shortfall years (S_Y), and risk-adjusted success (RAS), consider the evidence in Exhibit 1, based on results presented and discussed in Estrada [2017, 2018]. For each of these three decision variables, the first column shows the asset allocation selected among the 11 considered, and the second column shows the value of the variable on which such a choice is based. To illustrate, in Australia, the failure rate selects an allocation with 100% in stocks, which is the one for which F is the lowest across all the asset allocations considered, at 3.5%; shortfall years selects a 60–40 stock–bond allocation, for which S_Y is the lowest, at 5.7 years; and RAS selects an allocation with 100% in stocks, for which RAS is the highest, at 6.0.

Exhibit 1
Optimal Asset Allocations

	Failure Rate		Shortfall Years		Risk-Adjusted Success	
Country	x_s	F	x_s	S_Y	x_s	**RAS**
Australia	100	3.5	60	5.7	100	6.0
Austria	80 & 60	44.2	90	14.7	80	1.6
Belgium	100	50.0	70	9.8	30	1.6
Canada	90–70	0.0	60	2.0	60	15.6
Denmark	90	1.2	70	1.7	90	13.6
Finland	100	33.7	0	12.7	0	1.8
France	100	53.5	100	9.0	100	1.5
Germany	70–50	53.5	100	13.5	0	1.6
Ireland	100	26.7	40	8.5	100	2.2
Italy	100	60.5	80	11.8	100	1.6
Japan	50	34.9	0	10.8	10	2.1
Netherlands	100	19.8	50	4.4	70	3.0
New Zealand	100–90	0.0	80	1.0	70	14.6
Norway	100–90	34.9	60	6.9	90	2.0
Portugal	50	34.9	70	8.0	50	2.1
South Africa	100–80	2.3	60	3.2	80	8.5
Spain	100	38.4	30	7.7	0	2.0
Sweden	60 & 40	16.3	30	3.4	40	3.6
Switzerland	50–40	24.4	0	5.1	10	3.8
U.K.	100	5.8	90	3.5	100	5.5
USA	100–70	3.5	80	2.0	70	8.0
World	100	14.0	100	5.8	100	3.5
Average x_s	**81**		**60**		**61**	

Notes: This exhibit shows, the lowest failure rate (F), lowest shortfall years (S_Y), and highest risk-adjusted success (RAS), as well as the asset allocation they correspond to, indicated by the proportion of stocks (x_s) in it, with the rest of the portfolio allocated to bonds, across 11 asset allocations with stock–bond proportions between 100–0 (all stocks) and 0–100 (all bonds) considered for each country, over 86 rolling 30-year retirement periods, beginning with 1900–1929 and ending with 1985–2014. 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, S_Y, and RAS as defined in Expressions (1), (2), and (6) in the text; F and x_s are expressed in %, and S_Y, in years. The data are described in Exhibit A1 in the appendix.

This exhibit highlights at least four interesting results. First, for any given decision variable (F, S_Y, or RAS), the strategy selected varies considerably from country to country. Second, for any given country, the strategy selected varies considerably depending on the variable used to make the selection. Third, only S_Y and RAS select some 0–100 stock–bond allocations, three in each case. Finally, on average, the failure rate selects more aggressive strategies than both S_Y and RAS.

EVIDENCE

This section discusses the global evidence based on 21 countries and the world market over the 115 years between 1900 and 2014. The first part discusses the data and methodology; the second part discusses the strategies selected by D-RAS and elaborates on some related issues.

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 long-term government bonds over the 1900–2014 period for 21 countries and the world market. Returns are real (adjusted by each country's inflation rate), in local currency (except for the world market, in dollars), 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 inflation-adjusted withdrawals, and a 30-year retirement period.[4] At the beginning of each year the annual withdrawal is made, the portfolio is then rebalanced to the target asset allocation for the year, and then it compounds at the observed return of stocks and bonds for that year. This process is repeated at the beginning of each year during the 30-year retirement period, at the end of which the portfolio has a terminal wealth or bequest that may be positive or 0. 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.

The analysis considers 11 stock–bond allocations ranging between 100–0 (all stocks) and 0–100 (all bonds), with nine allocations in between (90–10, 80–20,..., 20–80, and 10–90). The goal of the analysis that follows is to apply the framework proposed, based on D-RAS, to the selection of the optimal asset allocation for each country in the sample.

Evaluation of Strategies

Exhibit 2 shows, for the U.S. and the world markets, and for the 11 asset allocations considered, the relevant variables of the analytical framework proposed, namely, the failure rate (F); shortfall years (S_Y); years sustained when a strategy fails (Y_{S-F}); years sustained when a strategy succeeds (Y_{S-S}); the expected value (E), standard deviation (SD), and semideviation with respect to the length of the retirement period (SSD_L) of years sustained (Y_S); risk-adjusted success (RAS); and downside risk–adjusted success (D-RAS). Exhibit A2 in the appendix shows four of these variables (F, S_Y, RAS, and D-RAS) for all the markets in the sample. In both exhibits, the highest RAS and D-RAS across all the strategies evaluated for each market are highlighted.

Several interesting results follow from Exhibit 2. First, recall that RAS and D-RAS have the same numerator but different denominator, the latter capturing the risk of each strategy. If risk is viewed as $SD(Y_S)$, then the 0–100 allocation in the United States is just a bit riskier than the 100–0 allocation; based on $SSD_L(Y_S)$, however, the former allocation is almost six times riskier than the latter. Similarly, for the world market, the 0–100 allocation is less risky than the 100–0 allocation based on $SD(Y_S)$, although the former is over three times riskier based on $SSD_L(Y_S)$.

Second, and related, the failure rate and $SSD_L(Y_S)$ are more highly correlated than the failure rate and $SD(Y_S)$. The correlations between the failure rate and $SD(Y_S)$ are 0.83 in the United States and −0.69 in the world market, whereas those between the failure rate and $SSD_L(Y_S)$ are 0.97 in the United States and 0.95 in the world market. Across all countries in the sample, the correlation between the failure rate and $SD(Y_S)$ is −0.19 and that between the failure rate and $SSD_L(Y_S)$ is 0.74. Clearly, then, $SSD_L(Y_S)$ provides a risk assessment much more closely aligned with that of the failure rate than does $SD(Y_S)$.

Third, despite the previous result, both RAS and D-RAS select fairly similar strategies in the United States (70–30 in the first case, and 80–20 in the second) and the same strategy in the world market (100–0). As Exhibit A2 shows, however, this is not the case in all markets. In order to highlight the strategies selected by

[4] As is the case in Estrada [2018], the analysis is based on a 4% IWR, but the intuition behind the results is similar for other IWRs. Also, 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.

Exhibit 2

U.S. and World: Relevant Variables

Stocks-Bonds	100–0	90–10	80–20	70–30	60–40	50–50	40–60	30–70	20–80	10–90	0–100
USA											
F	3.5	3.5	3.5	3.5	4.7	8.1	15.1	25.6	40.7	64.0	65.1
S_Y	5.7	3.3	2.0	2.7	3.0	2.9	3.2	3.9	4.9	5.6	7.9
$Y_{S\text{-}F}$	24.3	26.7	28.0	27.3	27.0	27.1	26.8	26.1	25.1	24.4	22.1
$Y_{S\text{-}S}$	113.7	102.2	91.7	82.0	73.7	66.9	61.9	58.5	58.0	67.2	61.0
$E(Y_S)$	110.6	99.6	89.5	80.1	71.5	63.7	56.6	50.2	44.6	39.8	35.7
$SD(Y_S)$	16.4	13.9	11.7	10.0	9.8	10.9	12.5	14.1	16.2	20.5	18.6
RAS	6.7	7.2	7.7	8.0	7.3	5.9	4.5	3.6	2.8	1.9	1.9
$SSD_L(Y_S)$	1.1	0.6	0.4	0.5	0.6	0.8	1.2	2.0	3.2	4.5	6.4
D-RAS	104.5	160.0	239.6	160.9	110.6	78.1	46.1	25.7	14.1	8.9	5.6
World											
F	14.0	15.1	16.3	20.9	23.3	29.1	36.0	36.0	38.4	45.3	59.3
S_Y	5.8	6.2	7.1	7.4	8.4	8.5	8.6	10.5	11.3	10.6	9.7
$Y_{S\text{-}F}$	24.2	23.8	22.9	22.6	21.7	21.5	21.4	19.5	18.7	19.4	20.3
$Y_{S\text{-}S}$	94.4	87.0	80.4	76.4	71.5	68.9	67.6	62.6	59.0	57.7	61.9
$E(Y_S)$	84.6	77.4	71.0	65.1	59.9	55.2	50.9	47.1	43.5	40.3	37.2
$SD(Y_S)$	24.3	22.6	21.2	21.9	21.1	21.5	22.2	20.7	19.6	19.1	20.4
RAS	3.5	3.4	3.3	3.0	2.8	2.6	2.3	2.3	2.2	2.1	1.8
$SSD_L(Y_S)$	2.2	2.4	2.9	3.4	4.0	4.6	5.2	6.3	7.0	7.2	7.5
D-RAS	38.8	32.0	24.6	19.3	14.9	12.1	9.8	7.5	6.2	5.6	5.0

Notes: This exhibit shows, for 11 asset allocations with stock–bond proportions between 100–0 (all stocks) and 0–100 (all bonds), and for the U.S. and the world markets, the failure rate (F); shortfall years (S_Y); years sustained when a strategy fails (Y_{S-F}); years sustained when a strategy succeeds (Y_{S-S}); the expected value (E), standard deviation (SD), and semideviation with respect to the length of the retirement period (SSD_L) of years sustained (Y_S); risk-adjusted success (RAS); and downside risk–adjusted success (D-RAS), all as defined in the text, over 86 rolling 30-year retirement periods, beginning with 1900–1929 and ending with 1985–2014. 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 to the stock–bond allocations in the first row. F is expressed in %; S_Y and Y_S are expressed in years. The data are described in Exhibit A1 in the appendix.

both RAS and D-RAS, Exhibit 3 compiles these selections based on the results reported in Exhibit A2. All the figures in the exhibit represent the proportion of stocks in the allocation selected, with the rest of the portfolio allocated to bonds.

Note that, on average, D-RAS selects more-aggressive allocations than RAS does. In fact, D-RAS selects strategies with an average allocation to stocks of 85%; the average allocation to stocks based on RAS is only 61%. This is largely due to the fact that, unlike $SD(Y_S)$, $SSD_L(Y_S)$ does not penalize aggressive strategies with a very large upside that stems from very large bequests.

To elaborate on the previous point, note from (5) that $SD(Y_S)$ may be high because $(L - S_Y)$ is much lower than $E(Y_S)$ or because $(L + B_Y)$ is much higher than $E(Y_S)$. Consider any given large difference such that $(L - S_Y) - E(Y_S) = (L + B_Y) - E(Y_S)$. These two large gaps have the same impact on $SD(Y_S)$ simply because they are squared in the calculation of (5). However, a retiree is hardly indifferent to whether he or she fails to sustain a withdrawal plan by many years or leaves a very large bequest. Thus, unlike $SSD_L(Y_S)$, $SD(Y_S)$ and hence RAS tend to penalize aggressive strategies that leave large bequests.[5]

The previous point implies that $SSD_L(Y_S)$ may be a more plausible measure of risk than $SD(Y_S)$, and therefore that D-RAS may be a more plausible measure of risk-adjusted success than RAS. To underscore this point, consider Exhibit 4, which shows, across the

[5] For the sake of completeness, also note 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 N/A in Canada and New Zealand in Exhibit A2 in the appendix.

EXHIBIT 3

Optimal Asset Allocations: RAS vs. D-RAS

Country	x_s (RAS)	x_s (D-RAS)
Australia	100	90
Austria	80	70
Belgium	30	100
Canada	60	60
Denmark	90	70
Finland	0	100
France	100	100
Germany	0	100
Ireland	100	100
Italy	100	100
Japan	10	100
Netherlands	70	70
New Zealand	70	80
Norway	90	80
Portugal	50	70
South Africa	80	100
Spain	0	90
Sweden	40	40
Switzerland	10	80
U.K.	100	100
USA	70	80
World	100	100
Average	**61**	**85**

Notes: This exhibit shows, based on the results reported in Exhibit A2 in the appendix, the asset allocation selected among the 11 considered, indicated by the proportion of stocks (x_s) in it, with the rest of the portfolio allocated to bonds, based on the highest risk-adjusted success (RAS) and downside risk–adjusted success (D-RAS). All figures in %.

EXHIBIT 4

Correlation with the Failure Rate: RAS vs. D-RAS

Country	*F* & RAS	*F* & D-RAS
Australia	–0.92	–0.92
Austria	–0.80	–0.80
Belgium	0.34	–0.92
Canada	–0.79	–0.74
Denmark	–0.85	–0.85
Finland	0.88	–0.82
France	–0.98	–0.41
Germany	0.69	–0.47
Ireland	–1.00	–0.97
Italy	–0.94	–0.99
Japan	0.40	–0.53
Netherlands	–0.96	–0.99
New Zealand	–0.82	–0.60
Norway	–0.94	–0.95
Portugal	–0.74	–0.69
South Africa	–0.90	–0.74
Spain	–0.01	–0.95
Sweden	–0.65	–0.90
Switzerland	0.30	–0.82
U.K.	–0.90	–0.77
USA	–0.93	–0.77
World	–0.96	–0.85
Average	**–0.52**	**–0.79**

Notes: This exhibit shows, across the 11 asset allocations considered for each country, the correlation between the failure rate (F) and risk-adjusted success (RAS) and that between the failure rate and downside risk–adjusted success (D-RAS).

11 asset allocations considered for each country, the correlation between the failure rate and RAS and that between the failure rate and D-RAS.

Note that because the failure rate is a variable to be minimized, and RAS and D-RAS are variables to be maximized, the correlation between the failure rate and these two ratios is expected to be negative. Interestingly, although that is in fact the case for the correlation between the failure rate and D-RAS in every country, that is not the case for the correlation between the failure rate and RAS in 5 of the 21 countries in the sample. Note also that the failure rate is more highly correlated with D-RAS (−0.79) than it is with RAS (−0.52), on average. This implies that the failure rate and D-RAS rank competing strategies much more similarly than the failure rate and RAS do.

ASSESSMENT

The definition of risk is one of the most contentious issues in finance and a controversy that most likely will never go away. Although volatility is arguably the variable most widely used to assess risk, many alternatives exist. One of such alternatives is the semideviation, which measures volatility only below, but not above, a chosen benchmark. Which of these two measures of risk is more plausible is part of the debate about how to properly assess risk, which in turn has implications for the selection of retirement strategies.

Blanchett [2007] argues that while "standard deviation is the most common definition of risk for investment purposes, investors do not fear making too much money (upside deviation), which is why other definitions of risk (such as downside risk) may prove to be more useful." The framework proposed here to evaluate retirement strategies is based, precisely, on this downside risk perspective.

Although the failure rate is the variable most widely used to evaluate retirement strategies, it has several flaws. Estrada [2017] aims to complement the failure rate with the shortfall years variable, in order to account for both how often and by how much a strategy failed. Furthermore, Estrada [2018] aims to replace the failure rate with the risk-adjusted success ratio, in order to account not just for the failure but also the success of the strategies considered.

Risk-adjusted success, however, assesses risk with the standard deviation, which penalizes successful strategies that leave large bequests, much the same as the Sharpe ratio penalizes strategies with large returns above the mean. In order to overcome this limitation, the framework proposed here replaces the standard deviation with the semideviation, thus viewing risk as uncertainty about years of withdrawals short from, but not larger than, the length of the retirement period. The resulting measure, downside risk–adjusted success, or D-RAS, is the variable proposed in this article to evaluate competing retirement strategies.

Financial planners may use this novel tool to help their clients select an optimal retirement strategy. D-RAS aims to be comprehensive enough to be used in isolation, although it may also be used to provide additional perspective to financial planners that prefer to use other tools, such as the failure rate. Either way, an enhanced toolbox can never hurt, and providing such enhancement is the ultimate goal of this article.

Downside risk–adjusted success tends to select more aggressive strategies than the three other variables considered here, namely, the failure rate, shortfall years, and risk-adjusted success. In addition, it tends to select strategies with relatively low failure rates that tend to leave large bequests, thus adding to its plausibility. For these reasons, D-RAS is proposed as the ultimate variable to be used in a comprehensive and plausible evaluation of retirement strategies.

Appendix

Exhibit A1

Summary Statistics

	AM	GM	SD	SSD	Min	Max
Panel 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
U.K.	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
World	6.6	5.2	17.4	9.4	–41.0	68.2
Panel B: Bonds						
Australia	2.5	1.7	13.2	7.6	–26.6	62.2
Austria	4.9	–3.8	51.2	20.1	–94.4	441.6
Belgium	1.6	0.4	15.0	9.9	–45.6	62.3
Canada	2.8	2.2	10.4	5.4	–25.9	41.7
Denmark	3.9	3.3	11.9	5.1	–18.2	50.1
Finland	1.5	0.2	13.7	10.9	–69.5	30.2
France	1.1	0.2	13.0	9.5	–43.5	35.9
Germany	1.3	–1.4	15.8	12.4	–95.0	62.5
Ireland	2.7	1.6	15.1	8.0	–34.1	61.2
Italy	0.2	–1.2	14.7	11.8	–64.3	35.5
Japan	1.7	–0.9	19.7	14.7	–77.5	69.8
Netherlands	2.2	1.7	9.8	5.2	–18.1	32.8
New Zealand	2.5	2.1	9.0	4.8	–23.7	34.1
Norway	2.6	1.9	12.0	6.8	–48.0	62.1
Portugal	2.5	0.8	18.7	11.2	–49.7	82.4
South Africa	2.4	1.9	10.4	5.9	–32.6	37.1
Spain	2.5	1.8	12.6	7.1	–30.2	53.2
Sweden	3.5	2.8	12.7	5.9	–37.0	68.2
Switzerland	2.7	2.3	9.4	4.3	–21.4	56.1
U.K.	2.4	1.6	13.7	7.1	–30.7	59.4
USA	2.5	2.0	10.4	5.3	–18.4	35.1
World	2.5	1.9	11.3	6.0	–32.0	46.7

Notes: 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 (except for the world market, in dollars), and account for capital gains/losses and cash flows (dividends or coupons). All figures are in %.

Exhibit A2
Asset Allocation Selection

Stocks-Bonds	100–0	90–10	80–20	70–30	60–40	50–50	40–60	30–70	20–80	10–90	0–100
Australia											
F	3.5	4.7	5.8	7.0	12.8	17.4	30.2	38.4	53.5	62.8	65.1
S_Y	12.0	9.0	7.6	7.5	5.7	6.5	6.5	7.8	7.8	9.3	10.9
RAS	6.0	5.4	5.0	4.7	3.6	3.2	2.4	2.1	1.8	1.6	1.6
D-RAS	67.7	68.4	63.1	50.6	42.2	27.5	17.7	11.3	8.1	5.5	4.0
Austria											
F	52.3	47.7	44.2	45.3	44.2	45.3	46.5	51.2	48.8	50.0	54.7
S_Y	14.9	14.7	15.2	15.2	16.2	16.6	16.9	16.3	18.0	18.7	18.3
RAS	1.5	1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.5	1.5	1.5
D-RAS	4.0	4.6	4.9	5.0	4.7	4.4	4.0	3.6	3.1	2.6	2.2
Belgium											
F	50.0	51.2	52.3	54.7	53.5	54.7	55.8	57.0	60.5	64.0	69.8
S_Y	10.2	10.1	10.0	9.8	10.5	10.7	11.0	11.3	11.2	11.3	11.1
RAS	1.6	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.5
D-RAS	7.7	7.6	7.4	7.1	6.4	5.9	5.4	4.9	4.4	4.0	3.5
Canada											
F	1.2	0.0	0.0	0.0	1.2	14.0	17.4	26.7	44.2	61.6	64.0
S_Y	4.0	N/A	N/A	N/A	2.0	2.8	5.4	5.8	5.8	6.8	8.7
RAS	12.5	N/A	N/A	N/A	15.6	4.4	3.9	3.1	2.3	1.7	1.6
D-RAS	231.4	N/A	N/A	N/A	317.5	60.5	25.0	17.1	12.3	8.1	5.7
Denmark											
F	3.5	1.2	2.3	3.5	4.7	10.5	19.8	30.2	39.5	45.3	53.5
S_Y	4.0	5.0	2.5	1.7	1.8	2.1	2.8	3.3	4.6	5.9	6.8
RAS	7.9	13.6	10.1	8.4	7.3	4.7	3.3	2.5	2.1	1.9	1.6
D-RAS	103.5	144.0	202.8	245.4	198.3	106.3	56.8	36.2	22.0	14.9	11.0
Finland											
F	33.7	36.0	37.2	38.4	38.4	40.7	43.0	45.3	47.7	57.0	68.6
S_Y	13.0	13.1	13.5	14.1	14.8	14.6	14.7	14.8	15.0	13.6	12.7
RAS	1.6	1.6	1.6	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.8
D-RAS	15.9	14.1	12.3	10.4	8.7	7.4	6.0	4.9	3.9	3.2	2.6
France											
F	53.5	55.8	57.0	59.3	58.1	59.3	59.3	60.5	58.1	57.0	57.0
S_Y	9.0	9.7	10.4	10.6	11.4	11.5	12.0	12.2	13.0	14.0	14.6
RAS	1.5	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
D-RAS	8.6	8.0	7.5	7.3	6.8	6.5	6.1	5.7	5.2	4.5	4.1
Germany											
F	54.7	54.7	54.7	53.5	53.5	53.5	54.7	54.7	54.7	55.8	57.0
S_Y	13.5	13.7	14.3	14.9	15.2	15.5	15.4	15.8	16.1	16.2	16.3
RAS	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.6
D-RAS	7.8	7.1	6.3	5.6	5.1	4.6	4.2	3.7	3.3	2.9	2.5
Ireland											
F	26.7	27.9	29.1	31.4	36.0	40.7	50.0	59.3	64.0	66.3	66.3
S_Y	8.5	8.8	9.1	9.1	8.5	8.7	8.5	8.7	9.8	10.9	12.1
RAS	2.2	2.2	2.2	2.1	2.0	1.9	1.7	1.5	1.4	1.3	1.4
D-RAS	18.8	17.0	15.1	13.6	12.5	10.6	9.0	7.3	5.7	4.6	3.8

(continued)

Exhibit A2 *(continued)*
Asset Allocation Selection

Stocks-Bonds	100–0	90–10	80–20	70–30	60–40	50–50	40–60	30–70	20–80	10–90	0–100
Italy											
F	60.5	65.1	67.4	69.8	70.9	72.1	75.6	77.9	79.1	82.6	88.4
S_Y	12.3	11.8	11.8	12.0	12.1	12.5	12.3	12.3	12.5	12.6	12.3
RAS	1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.3	1.4	1.4	1.3
D-RAS	3.7	3.6	3.5	3.3	3.2	3.0	2.9	2.7	2.5	2.3	2.1
Japan											
F	37.2	36.0	36.0	36.0	36.0	34.9	36.0	38.4	39.5	41.9	59.3
S_Y	13.6	13.8	13.6	13.5	13.4	13.8	13.7	13.1	13.1	13.0	10.8
RAS	1.5	1.6	1.6	1.6	1.7	1.8	1.9	1.9	2.0	2.1	1.9
D-RAS	15.8	13.9	12.3	10.8	9.4	8.1	6.9	6.2	5.3	4.6	4.1
Netherlands											
F	19.8	22.1	20.9	20.9	23.3	32.6	41.9	51.2	55.8	61.6	61.6
S_Y	7.1	5.4	5.2	4.7	4.7	4.4	4.8	5.6	6.9	8.0	9.5
RAS	2.7	2.6	2.8	3.0	2.9	2.5	2.2	2.0	1.9	1.8	1.9
D-RAS	29.7	34.4	34.2	34.7	29.6	24.2	17.4	12.1	8.4	6.2	4.6
New Zealand											
F	0.0	0.0	1.2	1.2	3.5	11.6	22.1	34.9	48.8	51.2	65.1
S_Y	N/A	N/A	1.0	3.0	2.7	3.0	3.8	4.9	5.5	7.3	7.8
RAS	N/A	N/A	14.4	14.6	8.9	5.0	3.6	2.8	2.4	2.4	2.0
D-RAS	N/A	N/A	743.3	226.7	133.8	58.8	29.9	16.7	11.3	7.4	5.5
Norway											
F	34.9	34.9	39.5	45.3	50.0	52.3	55.8	58.1	64.0	68.6	70.9
S_Y	8.8	8.5	7.6	7.1	6.9	7.2	7.5	7.8	8.2	8.9	9.9
RAS	2.0	2.0	1.9	1.7	1.6	1.6	1.5	1.6	1.5	1.5	1.5
D-RAS	12.9	13.4	13.8	13.5	12.5	11.0	9.4	8.1	6.6	5.3	4.2
Portugal											
F	46.5	45.3	43.0	46.5	36.0	34.9	44.2	50.0	51.2	52.3	53.5
S_Y	11.9	10.7	9.6	8.0	9.6	10.7	9.9	10.5	11.9	13.1	14.4
RAS	1.4	1.5	1.7	1.7	2.1	2.1	1.9	1.7	1.7	1.7	1.6
D-RAS	8.9	9.4	10.0	10.9	9.7	8.4	7.6	6.2	5.0	4.2	3.5
South Africa											
F	2.3	2.3	2.3	3.5	5.8	7.0	16.3	33.7	43.0	59.3	67.4
S_Y	3.5	3.5	4.5	3.3	3.2	4.5	4.0	4.6	6.1	6.8	8.5
RAS	7.9	8.2	8.5	7.4	6.2	6.0	4.3	3.1	3.0	2.7	2.6
D-RAS	276.1	236.3	156.6	146.5	99.9	54.7	33.9	17.2	9.9	6.4	4.2
Spain											
F	38.4	39.5	40.7	41.9	43.0	48.8	55.8	61.6	65.1	69.8	72.1
S_Y	12.1	11.1	10.6	10.0	9.7	8.7	8.0	7.7	8.0	8.3	8.8
RAS	1.8	1.9	1.9	1.9	2.0	1.9	1.8	1.8	1.8	1.9	2.0
D-RAS	7.8	8.1	8.0	8.0	7.7	7.5	7.2	6.5	5.7	4.8	4.1
Sweden											
F	24.4	20.9	18.6	17.4	16.3	18.6	16.3	30.2	41.9	45.3	51.2
S_Y	10.2	10.3	9.9	8.7	7.3	5.2	4.6	3.4	4.3	6.4	8.1
RAS	2.1	2.3	2.5	2.8	3.0	3.0	3.6	2.7	2.3	2.2	2.1
D-RAS	27.1	26.6	26.6	28.0	30.6	35.3	36.9	32.0	18.7	10.7	7.1

(continued)

EXHIBIT A2 (continued)
Asset Allocation Selection

Stocks-Bonds	100–0	90–10	80–20	70–30	60–40	50–50	40–60	30–70	20–80	10–90	0–100
Switzerland											
F	31.4	29.1	27.9	26.7	25.6	24.4	24.4	29.1	29.1	36.0	53.5
S_Y	9.7	9.5	8.9	8.6	8.5	8.4	8.0	6.6	6.9	6.1	5.1
RAS	2.1	2.3	2.5	2.7	2.9	3.1	3.4	3.4	3.7	3.8	3.5
D-RAS	12.2	12.4	12.8	12.7	12.4	12.0	11.8	12.0	10.7	10.0	9.0
U.K.											
F	5.8	11.6	18.6	20.9	22.1	23.3	33.7	48.8	61.6	66.3	66.3
S_Y	4.0	3.5	3.9	5.5	7.1	8.4	7.4	7.2	8.0	9.5	11.1
RAS	5.5	3.9	3.1	2.9	2.9	2.9	2.4	2.0	1.6	1.5	1.5
D-RAS	100.4	73.6	46.8	28.6	19.6	14.6	12.2	9.5	6.9	5.2	4.0
USA											
F	3.5	3.5	3.5	3.5	4.7	8.1	15.1	25.6	40.7	64.0	65.1
S_Y	5.7	3.3	2.0	2.7	3.0	2.9	3.2	3.9	4.9	5.6	7.9
RAS	6.7	7.2	7.7	8.0	7.3	5.9	4.5	3.6	2.8	1.9	1.9
D-RAS	104.5	160.0	239.6	160.9	110.6	78.1	46.1	25.7	14.1	8.9	5.6
World											
F	14.0	15.1	16.3	20.9	23.3	29.1	36.0	36.0	38.4	45.3	59.3
S_Y	5.8	6.2	7.1	7.4	8.4	8.5	8.6	10.5	11.3	10.6	9.7
RAS	3.5	3.4	3.3	3.0	2.8	2.6	2.3	2.3	2.2	2.1	1.8
D-RAS	38.8	32.0	24.6	19.3	14.9	12.1	9.8	7.5	6.2	5.6	5.0

Notes: This exhibit shows, for 11 asset allocations with stock–bond proportions between 100–0 (all stocks) and 0–100 (all bonds, and for all countries in the sample, 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 (9) in the text, over 86 rolling 30-year retirement periods, beginning with 1900–1929 and ending with 1985–2014. 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 to the stock–bond allocations in the first row. F is expressed in % and S_Y in years. The data are described in Exhibit A1.

ACKNOWLEDGMENTS

I would like to thank Jack Rader for his comments. Patricia Palgi provided valuable research assistance. IESE's Center for International Finance (CIF) kindly provided support for this research. The views expressed in this article and any errors that may remain are entirely my own.

REFERENCES

Bengen, W. 1994. "Determining Withdrawal Rates Using Historical Data." *Journal of Financial Planning*, 7 (4): 171–180.

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

Dimson, E., P. Marsh, and M. Staunton. *Triumph of the Optimists: 101 Years of Investment Returns*. Princeton University Press, 2002.

——. *Credit Suisse Global Investment Returns Sourcebook: 2016*. Zurich: Credit Suisse Research Institute, 2016.

Estrada, J. 2006. "Downside Risk in Practice." *Journal of Applied Corporate Finance*, 18 (1): 117–125.

——. 2017. "Refining the Failure Rate." *The Journal of Retirement*, 4 (3): 63–76.

——. 2018. "From Failure to Success: Replacing the Failure Rate." *The Journal of Wealth Management*, 20 (4): 9–21.

Milevsky, M. 2016. "It's Time to Retire Ruin (Probabilities)." *Financial Analysts Journal*, 72 (2): 8–12.