Target-Date Funds, Glidepaths, and Risk Aversion

JAVIER ESTRADA

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

KEY FINDINGS

- This article explores why target-date funds switch from a goal of capital accumulation early in the accumulation period to the goal of downside protection as individuals approach retirement.
- This switch is motivated by the increase in risk aversion observed as individuals age, which leads them to value downside protection more as they approach retirement.
- The evidence here shows that if individuals roughly double their risk aversion during the last 25 years of their working period, they would choose asset allocations similar to those featured by the glidepaths of target-date funds.

ABSTRACT: *Target-date funds feature asset allocations that become increasingly conservative as investors approach retirement. An important shortcoming of this strategy is that it is suboptimal in terms of capital accumulation, which begs the question of why these funds are so popular. A possible answer is that investors become more risk averse as they age, gradually favoring more downside protection as they approach retirement. The main issue explored in this article is how much more risk averse would investors need to become during their working years to select asset allocations similar to those in target-date funds; the evidence here shows that investors would have to roughly double their risk aversion during the last 25 years of their working period. An intuitive interpretation of this result, based on how much an individual would pay to avoid a gamble, is also discussed.*

TOPICS: ***Equity portfolio management, retirement, risk management, wealth management****

*All articles are now categorized by topics and subtopics. **View at PM-Research.com.**

Target-date funds (TDFs) are, and have been for some time, the most popular default option in defined contribution retirement plans. Although they were introduced by Barclays Global Investors in 1993, when the company launched its LifePath Portfolios, interest in TDFs took off when they became a Qualified Default Investment Alternative (QDIA) with the passage of the Pension Protection Act (PPA) of 2006.[1]

Despite their seemingly plausible underlying strategy, with an asset allocation that becomes increasingly conservative as retirement approaches, TDFs have not been free from criticism. One of their main drawbacks is that their declining-equity glidepath

[1]Although TDFs were one of the three QDIAs identified in the PPA, it was the one to which plan sponsors and individuals overwhelmingly gravitated.

is suboptimal in terms of capital accumulation.[2] In fact, both theory and evidence suggest that if an investor aims to maximize the size of their retirement portfolio, their asset allocation should become more (rather than less) aggressive over time; see Basu and Drew (2009); Arnott, Sherrerd, and Wu (2013); and Estrada (2014), among others.

Why do TDFs feature a declining-equity glidepath, and why are these products so popular with investors, despite this important shortcoming? The most likely answer is that investors prioritize capital accumulation early in their working years and gradually switch to prioritize capital protection as they approach retirement. This is consistent with survey evidence showing that in the last few years before retirement, most TDF investors want the fund to provide strong protection against losses; see ING Investment Management (2012).

This survey evidence seems to suggest that investors become more risk averse as they age, a hypothesis that has some empirical support. In fact, Albert and Duffy (2012) reported experimental evidence revealing that older individuals are more risk averse, and have higher discount rates, than younger individuals. Viewed through the lens of this evidence, asset management companies seem to be offering just what investors are demanding—that is, a gradual switch from upside potential to downside protection as retirement approaches.

The declining-equity glidepath featured by TDFs, the preference for strong protection against losses when approaching retirement, and the positive relationship between risk aversion and age all come together in the ultimate question posed in this article: How would an investor's attitude toward risk have to evolve over time so that the investor would choose a glidepath similar to that featured in TDFs?

Answering this question requires, first, specifying a benchmark glidepath; second, characterizing the preferences of a representative investor; and third, asking how the investor's risk aversion would have to evolve over time so that they would choose the asset allocations in the benchmark glidepath. That is precisely what is done in this article, resulting in the following main finding: To choose a glidepath similar to that featured in TDFs, an investor's risk aversion would have to roughly double during the last 25 years of the accumulation period.

To provide some intuition for this somewhat abstract result, an individual is faced with a gamble in order to determine how much he would paid to avoid it, at different times during the accumulation period, or similarly at different levels of risk aversion. To avoid the gamble, an individual whose risk aversion increases from the lowest to the highest value of those estimated here would be willing to pay 131% more on the retirement date than he would pay when being 25 years away from retirement. The levels of risk aversion obtained are consistent with previous estimates reported in the literature, as well as with widely accepted values for asset allocation.

The rest of the article is organized as follows. The next section discusses declining-equity glidepaths, risk aversion, and the main research questions. The following section discusses the benchmark glidepath, the representative investor, the data, the methodology and its implementation, and the main results of the inquiry. The final section concludes with an assessment.

THE ISSUE

This section discusses three issues that set the stage for the empirical analysis in the next section. First it discusses the main shortcoming of declining-equity glidepaths, then it discusses some evidence on risk aversion, and finally it discusses the two main research questions posed in this article.

Declining-Equity Glidepaths

TDFs have been criticized in a number of ways, among them that they are too aggressive, that they are too conservative, that they typically exclude alternative assets, that they focus on just one variable (years away from retirement), and that all the funds within a TDF typically are from the same asset management company that offers the TDF.

The relevant criticism for the purpose of this article is that the declining-equity glidepath featured in TDFs is suboptimal in terms of capital accumulation. In fact, it is trivial to show that a strategy that exposes a small portfolio (what investors typically have early in their working years) to high returns (the result of an aggressive asset

[2] A glidepath is the relationship between a fund's asset allocation and the number of years that the fund investors are away from their retirement. A declining-equity glidepath refers to an asset allocation that gradually reduces the proportion of stocks and increases the proportion of bonds, thus making the portfolio increasingly conservative over time.

allocation), and a large portfolio (what investors typically have approaching retirement, after years of contributions and compounding) to low returns (the result of a conservative asset allocation), will almost certainly be outperformed by a strategy that does the opposite.[3]

Basu and Drew (2009); Arnott, Sherrerd, and Wu (2013); and Estrada (2014) consider declining-equity glidepaths and their mirrors (strategies that remain invested in stocks and bonds the same amount of time but evolve in the opposite direction, from less aggressive to more aggressive) and find that declining-equity glidepaths underperform rising-equity glidepaths in terms of capital accumulation, both on average and in bad scenarios. In fact, declining-equity glidepaths also underperform constant-equity glidepaths, as long as the underlying asset allocation of the latter is aggressive enough.[4]

Risk Aversion

Why do TDFs feature an asset allocation that becomes gradually more conservative over time, and why are these products so popular with investors, if the resulting retirement portfolio is smaller than it could be with the opposite strategy? The most plausible answer seems to be that asset management companies are simply providing what investors demand, which is to prioritize upside potential early in the working period and gradually switch to prioritize downside protection as investors approach retirement.

This strategy is also consistent with the theory of time diversification, which suggests that risk is a function of the holding period.[5] In practice, this usually translates into the idea that stocks are risky in the short term, but much less so in the long term, and that stocks are riskier than bonds in the short term, but the opposite is the case in the long term. A corollary of time diversification is that young investors should have a high (low) exposure to stocks (bonds) and older investors should have the opposite.[6]

The strategy also seems to be consistent with investor preferences. In a survey of more than 500 defined contribution plan participants, ING Investment Management (2012) finds that 93% of TDF investors expect the fund to provide strong protection against losses when approaching and in retirement. The survey also finds that, when approaching and in retirement, if asked to choose between stronger protection against losses or a stronger growth potential, 80% of TDF investors (and 66% of non-TDF investors) prefer the former.

This survey evidence is consistent with experimental evidence reported by Albert and Duffy (2012). They asked two groups of individuals, younger and older, to perform a paired-lottery choice task commonly used in experimental economics to elicit risk aversion and found the older group to be more risk averse and to have a higher discount rate than the younger group. They also discussed other studies that report results consistent with their findings.

The Research Questions

Three facts are worth highlighting at this point. First, all TDFs feature a declining-equity glidepath; second, survey evidence shows that as retirement approaches investors clearly prefer protection against losses over potential for growth; and third, experimental evidence suggests that risk aversion increases with age. These three facts lead directly to the first and main question posed in this article: How would an investor's attitude toward risk have to evolve over time so that the investor would choose a glidepath similar to that featured by TDFs?

Answering this question requires three steps: first to specify a benchmark glidepath, then to characterize the preferences of a representative investor, and finally to ask how the investor's risk aversion would have to evolve

[3]Capital accumulation, or more precisely the maximization of the terminal value of the portfolio, is a plausible, though not necessarily the only, goal. Formally, it is equivalent to the geometric mean maximization framework pioneered by Latane (1959); see also Estrada (2010) and De Santiago and Estrada (2013). The fact that declining-equity glidepaths are suboptimal given this goal is unarguable, but as an anonymous referee rightly points out, this goal is one of the many that could be pursued.

[4]An anonymous referee rightly points out that these results depend on the performance metric considered and the definition of risk used in the analysis.

[5]Time diversification is a wide-ranging and controversial topic with many and varied arguments supporting and rejecting its validity. A broad discussion of time diversification is beyond the scope of this article, but interested readers will find an in-depth discussion of this issue in Estrada (2013).

[6]Many alternative explanations exist for this corollary, which is implicitly behind the asset allocation recommendations of most financial advisors and investor questionnaires. One of the leading explanations is the depletion of human capital as individuals age; see Bodie, Merton, and Samuelson (1992) and Mladina and Grant (2019).

over time so that he would choose the asset allocations in the benchmark glidepath. These steps are discussed in the next section.

The second research question posed here aims to complement the first. Having established how risk aversion would have to evolve over time for a representative investor to choose the asset allocations in the benchmark glidepath, the next step is to ask how those levels of risk aversion can be characterized in a practical way. Most practitioners find the value of a risk aversion coefficient to be an abstract figure without much intuition. However, having an individual face a gamble, and exploring how much that person would be willing to pay to avoid it, yields a useful perspective, particularly when applied to the range of risk aversion coefficients obtained from the first question.

EVIDENCE

This section discusses the results of the inquiry. First it discusses the benchmark glidepath and the representative investor; then it discusses the data and methodology; and finally it discusses how the methodology is applied, the main results in terms of risk aversion, and a practical interpretation of the results.

The Benchmark Glidepath

The first of the three steps of the analysis consists of specifying the glidepath that will be faced by the representative investor. Different asset management companies offer somewhat different glidepaths, diverging in the assets included in the funds, as well as in how aggressive or conservative the asset allocation is at different points in time, including on the retirement date.

The glidepath used here as a benchmark is the one featured by Vanguard, the leading provider of TDFs.[7] The far-left column of Exhibit 1 shows the number of years away from retirement (YAR) for investors in Vanguard's TDFs. The second and third columns show the proportion of stocks and bonds at different points along the accumulation period. The remaining four columns show the breakdown between US and international (world excluding US) stocks and bonds, with the first two columns showing the split between US stocks and international stocks and the two far-right columns showing the split between US bonds and international bonds. This glidepath is based on Donaldson et al. (2019), who discuss Vanguard's approach to TDFs, as well as on the asset allocation of Vanguard's TDFs at year-end 2019.

EXHIBIT 1
The Benchmark Glidepath

YAR	S	B	S-US	S-exUS	B-US	B-exUS
Up to 25	90%	10%	54%	36%	7%	3%
20	85%	15%	51%	34%	11%	5%
15	75%	25%	45%	30%	18%	8%
10	70%	30%	42%	28%	21%	9%
5	60%	40%	36%	24%	28%	12%
0	50%	50%	30%	20%	35%	15%

Notes: This exhibit shows Vanguard's asset allocation for its target-date funds at different times during the accumulation period. For each number of years away from retirement (YAR), the exhibit shows the proportion of stocks (S) and bonds (B), as well as the split between US stocks (S-US) and international stocks (S-exUS) and that between US bonds (B-US) and international bonds (B-exUS). Figures are rounded.

As the exhibit shows, as long as the investor is at least 25 years away from retirement, the asset allocation is an aggressive 90–10 stock–bond split. From that point on, the allocation to stocks gradually decreases, and to bonds gradually increases, so that on the retirement date the investor holds an equally weighted portfolio of stocks and bonds.[8] Throughout the glidepath, Vanguard maintains a 60–40 split between US and international stocks, and a 70–30 split between US and international bonds.[9]

The Representative Investor

The second of the three steps of the analysis consists of characterizing the representative investor. To that

[7]At the beginning of 2020, the four leading providers of TDFs were Vanguard (38% of assets under management), Fidelity (19%), T. Rowe Price (11%), and American Funds (11%). The rest of the companies all had less than 5% of assets under management. John Rekenthaler from Morningstar kindly provided this information.

[8]After the retirement date, Vanguard continues to reduce the allocation to stocks, and increase the allocation to bonds, until the fund reaches a 30–70 stock–bond split seven years into the retirement period. From that point on, the asset allocation is kept constant.

[9]When a TDF is five years away from the target retirement date, Vanguard introduces a small allocation to short-term Treasury Inflation-Protected Securities, which is omitted here because of the much shorter sample period available for this asset.

purpose, I consider an investor described by the widely used mean-variance utility function given by the following expression:

$$E(U) = \mu_p - \lambda \cdot \sigma_p^2, \tag{1}$$

where $E(U)$ denotes expected utility; μ_p and σ_p^2 denote a portfolio's expected return and risk, the latter measured by its variance; and λ is the coefficient of (relative) risk aversion.

This representative investor will be tasked with choosing, at different times during his accumulation period, the asset allocation that maximizes his utility, given different levels of risk aversion. His choices will then be compared with those in the benchmark glidepath to determine the level of risk aversion that equates both allocations. (More on this in the upcoming section.)

Data

Vanguard's TDFs are essentially built with four assets: US stocks and bonds and international (world excluding US) stocks and bonds. To assess the long-term performance of these four assets, the sample used here is the Dimson–Marsh–Staunton database, described in detail in Dimson, Marsh, and Staunton (2002), as well as in the annual Credit Suisse Global Investment Returns Yearbooks.

The sample period for the computation of all relevant summary statistics is 1900 to 2014. All returns are annual, real (adjusted by inflation), in dollars, and account for both capital gains/losses and cash flows (dividends or coupons). Exhibit 2 summarizes some characteristics of the four series of stock and bond returns in the sample, as well as the characteristics of two portfolios, a 60–40 split between US and international stocks, and a 70–30 split between US and international bonds. As already mentioned, these are the splits used by Vanguard in its TDFs.

As the exhibit shows, in terms of compound returns (GM), US stocks and bonds outperformed international stocks and bonds over the full sample period. Although US stocks were slightly more volatile than international stocks, US bonds were less volatile than international bonds. Unsurprisingly, the 60–40 portfolio of stocks had both a higher return and higher volatility than the 70–30 portfolio of bonds; their correlation over the whole sample period was a relatively low 0.31.

Exhibit 2
Data: Summary Statistics

	S-US	B-US	S-exUS	B-exUS	60–40	70–30
AM	8.5%	2.5%	6.2%	2.6%	7.5%	2.6%
GM	6.5%	2.0%	4.4%	1.6%	6.0%	2.1%
SD	20.0%	10.4%	19.0%	14.7%	17.6%	10.1%
ρ					0.31	

Notes: This exhibit shows summary statistics for the annual returns of four assets—US stocks (S-US) and bonds (B-US) and international stocks (S-exUS) and bonds (B-exUS)—as well as for two portfolios: a 60–40 split between US and international stocks and a 70–30 split between US and international bonds. The summary statistics include the arithmetic (AM) and geometric (GM) mean return, standard deviation of returns (SD), and the correlation between the 60–40 and the 70–30 portfolios (ρ). All returns are real, in dollars, and account for capital gains/losses and cash flows paid. The sample period is 1900 to 2014.

Methodology

The third of the three steps of the analysis consists of determining how the representative investor's risk aversion would have to evolve over time so that this investor would choose asset allocations similar to those in the benchmark glidepath. To that purpose, the following steps are taken:

1. For a holding period of 25 years (when the representative investor is 25 years away from retirement), the expected return and risk of 21 portfolios are calculated, ranging from 100% to 0% in the 60–40 portfolio of stocks, with the rest invested in the 70–30 portfolio of bonds, in steps of 5 percentage points (100%, 95%, 90%, …, 10%, 5%, 0%).
2. For a risk aversion coefficient (λ) equal to 0, the representative investor's expected utility is calculated using Equation (1) for each of the 21 portfolios in the previous step.
3. The highest of the 21 expected utility levels from the previous step determines the asset allocation the representative investor would select.
4. Steps 2 and 3 are repeated for $\lambda = 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 5.0$, and 10.0, which yields a matrix with 189 expected utility levels (21 portfolios × 9 risk aversion coefficients), and nine highest expected utility levels (one for each level of risk aversion), each determining an asset allocation selected by the representative investor.

5. These nine optimal asset allocations are then compared with the asset allocation in the benchmark glidepath with 25 years to the target retirement date; the relevant risk aversion coefficient is the one for which the asset allocation selected by the representative investor matches the one in the benchmark glidepath.
6. Steps 1–5 are repeated for holding periods of 20, 15, 10, 5, and 0, which yields six risk aversion coefficients, one for each of the six holding periods considered.

Two points are worth noticing about this methodology. First, accumulation (or working) periods are usually thought of as 40 years long. However, given that the asset allocation in the benchmark glidepath is constant until an individual is 25 years away from retirement, only the 25-year holding period is relevant; longer ones are redundant. Second, the preceding methodology omits one step that is easier to explain when discussing the evidence, which is done in the next section. For now, suffice it to say that the omitted step implies that it is possible to determine more than one level of risk aversion for each of the holding periods considered.

Application of the Methodology

Exhibit 3 illustrates the implementation of the steps described in the previous section, as well as the missing step mentioned, when the representative investor is 10 years away from retirement. The Stocks column shows the allocation to the 60–40 portfolio of stocks, with the rest being allocated to the 70–30 portfolio of bonds. The next two columns show the expected return (μ_p) and risk (σ_p) of 21 portfolios based on the weights in the far-left column, as well as on the parameters in Exhibit 2 for the 60–40 portfolio of stocks and the 70–30 portfolio of bonds.

Exhibit 3

Risk Aversion and Optimal Choice: 10 Years Away from Retirement

Stocks	μ_p	σ_p	0.0	0.5	1.0	1.5	2.0	2.5	3.0	5.0	10.0
100	7.5	17.6	0.075	0.060	0.044	0.029	0.013	–0.002	–0.018	–0.080	–0.236
95	7.3	16.9	0.073	0.059	0.044	0.030	0.016	0.001	–0.013	–0.070	–0.214
90	7.0	16.2	0.070	0.057	0.044	0.031	0.018	0.005	–0.008	–0.061	–0.193
85	6.8	15.5	0.068	0.056	0.044	0.032	0.020	0.008	–0.004	–0.053	–0.173
80	6.5	14.9	0.065	0.054	0.043	0.032	0.021	0.010	–0.001	–0.045	–0.155
75	6.3	14.2	0.063	0.053	0.043	0.033	0.023	0.012	0.002	–0.038	–0.139
70	6.0	13.6	0.060	0.051	0.042	0.033	0.024	0.014	0.005	–0.032	–0.124
65	5.8	13.0	0.058	0.050	0.041	0.033	0.024	0.016	0.007	–0.026	–0.111
60	5.6	12.4	0.056	0.048	0.040	0.032	0.025	0.017	0.009	–0.022	–0.099
55	5.3	11.9	0.053	0.046	0.039	0.032	0.025	0.018	0.010	–0.018	–0.089
50	5.1	11.4	0.051	0.044	0.037	0.031	0.024	0.018	0.011	–0.015	–0.080
45	4.8	11.0	0.048	0.042	0.036	0.030	0.024	0.018	0.012	–0.012	–0.073
40	4.6	10.6	0.046	0.040	0.034	0.029	0.023	0.017	0.012	–0.011	–0.067
35	4.3	10.3	0.043	0.038	0.032	0.027	0.022	0.017	0.011	–0.010	–0.063
30	4.1	10.0	0.041	0.036	0.030	0.025	0.020	0.015	0.010	–0.010	–0.060
25	3.8	9.9	0.038	0.033	0.028	0.024	0.019	0.014	0.009	–0.010	–0.059
20	3.6	9.7	0.036	0.031	0.026	0.021	0.017	0.012	0.007	–0.012	–0.059
15	3.3	9.7	0.033	0.028	0.024	0.019	0.014	0.010	0.005	–0.014	–0.061
10	3.1	9.8	0.031	0.026	0.021	0.016	0.012	0.007	0.002	–0.017	–0.065
5	2.8	9.9	0.028	0.023	0.018	0.013	0.009	0.004	–0.001	–0.021	–0.069
0	2.6	10.1	0.026	0.021	0.015	0.010	0.005	0.000	–0.005	–0.025	–0.076

Notes: Exhibit 3 shows the expected utility of a representative investor for different portfolios and levels of risk aversion. The Stocks column shows the allocation to the 60–40 portfolio of US and international stocks, with the rest invested in the 70–30 portfolio of US and international bonds. The next two columns show the expected return (μ_p) and risk (σ_p) of 21 portfolios (%) based on the weights in the Stocks column and the parameters in Exhibit 2. The numbers on the top row indicate different levels of risk aversion (λ). Expected utilities are calculated using Equation (1).

For an investor 10 years away from retirement, the benchmark glidepath in Exhibit 1 indicates a 70% allocation to stocks (and 30% to bonds), which is highlighted for reference in the far-left column of Exhibit 3. The fourth column of the exhibit considers a risk neutral investor ($\lambda = 0.0$); of the 21 portfolios the investor can choose from, the highest utility (highlighted) corresponds to a 100% allocation to stocks, which is not consistent with the 70% allocation to stocks in the benchmark glidepath. The next two columns show that the investor would make the same choice (100% stocks) if that person had risk aversion coefficients of 0.5 and 1.0.

Moving to the right, then, for $\lambda = 1.5$ the investor finds the highest utility (highlighted) by allocating 70% to stocks (hence 30% to bonds), which in this case is, in fact, the same allocation as in the benchmark glidepath for investors 10 years away from retirement. For $\lambda = 2.0$ or higher, the investor finds the highest utility for portfolios with allocations to stocks between 55% (for $\lambda = 2.0$) and 25% (for $\lambda = 10.0$), all of them different from the allocation in the benchmark glidepath for investors 10 years away from retirement.

Here is where the missing step in the methodology described in the previous section comes in. Having established that an investor with $\lambda = 1.5$ would choose an allocation consistent with that in the benchmark glidepath, the missing step involves a deeper search, in steps of 0.05, in the vicinity of this coefficient. In this case, the search (not shown in Exhibit 4) suggests that the investor would maximize his utility at the same 70% allocation to stocks if he had risk aversion coefficients between 1.45 and 1.55; for $\lambda < 1.45$ ($\lambda > 1.55$), he would choose a more aggressive (conservative) allocation.

Exhibit 4
Risk Aversion along the Accumulation Period

YAR	S	B	λ
Up to 25	90%	10%	1.10
20	85%	15%	1.15–1.20
15	75%	25%	1.35–1.40
10	70%	30%	1.45–1.55
5	60%	40%	1.75–1.95
0	50%	50%	2.25–2.55

Notes: Exhibit 4 shows, at each number of years away from retirement (YAR), the level of risk aversion (λ) that leads the representative investor to choose the allocation to stocks (S) and bonds (B) featured in the benchmark glidepath. S (B) is the allocation to the 60–40 (70–30) portfolio of US and international stocks (bonds).

Results

Repeating the same process just discussed at different points in time along the investor's accumulation period results in the risk aversion coefficients shown in Exhibit 4. In those cases in which a range is shown, the lower (higher) number is the lowest (highest) risk aversion coefficient consistent with the allocations in the benchmark glidepath.[10]

This exhibit shows at least two interesting results. First, to choose the allocations in the benchmark glidepath, the representative investor would have to become gradually more risk averse as he gets older. Combining this result with Albert and Duffy's (2012) finding that individuals do, in fact, get more risk averse as they age seems to validate the decision of asset management companies to offer TDFs with declining-equity glidepaths; they just seem to be offering what investors demand.[11]

Second, the figures in the exhibit show that in order to choose the allocations in the benchmark glidepath, the representative investor's risk aversion would not just have to marginally increase over time; it would have to more than double, from 1.10 to the 2.25–2.55 range, during the last 25 years of his accumulation period. (The next section provides some intuition behind this rather abstract result.)

Important to note, the risk aversion coefficients in Exhibit 4 are consistent with other estimates in the literature. Gandelman and Hernández-Murillo (2014) estimate risk aversion at the aggregate level for 75 countries and obtain a range between 0 and 3, a value in the vicinity of 1 for most of the countries, and a cross-sectional average of 0.98. Thomas (2016) reports that the UK Treasury recommends the use of a risk-aversion coefficient equal to 1. Baz and Guo (2017) argue that

[10]As already mentioned, the search for other λs is done in steps of 0.05.

[11]Many possible explanations exist for the fact that risk aversion increases with age. An anonymous referee suggests that it may be related to the decline in human capital as individuals age. Kurnianingsih et al. (2015) suggest that aging alters economic decision-making for losses through changes in both individual preferences and the strategies individuals employ. Grubb et al. (2016) suggest that age-related declines in rPPC gray matter volume account for age-related changes in risk preferences.

the most widely accepted values for asset allocation are in the 1–5 range, and Estrada and Kritzman (2019) find no differences in the asset allocations selected by a representative investor for risk aversion coefficients higher than 3.0. In short, the range of risk aversion coefficients in Exhibit 4 is consistent with other estimates and results reported in the literature.

An Intuitive Perspective of Risk Aversion

Many practitioners find the concepts of utility and risk aversion to be abstract and obscure. To provide some meaning to the risk aversion coefficients in Exhibit 4, I resort to one of the utility functions most widely used in finance and economics—the power utility function, which is given by this equation:

$$U(W) = \frac{W^{1-\lambda} - 1}{1-\lambda} \quad \textit{for } \lambda \geq 0, \tag{2}$$

where U, W, and λ denote utility, wealth, and the coefficient of risk aversion, which is 0 for risk neutral individuals and positive for risk averse ones. When $\lambda = 1$, the individual has log utility.[12]

Let's consider first an individual with $\lambda = 1.10$, which is the lowest level of risk aversion reported in Exhibit 4. Assume that this individual has $1 million and faces a gamble with a 50–50 chance to win or lose 10% of his capital. How much money would he accept to have with certainty to avoid the gamble? The answer is given by the certainty equivalent of wealth, which is equal to $994,487.[13] Put differently, this individual would be willing to pay up to $5,513 to avoid the gamble.

How would an individual with risk aversion in the 2.25–2.55 range behave? One with $\lambda = 2.25$ would have a certainty equivalent of wealth of $988,763, which means that she would be willing to pay up to $11,237 to avoid the gamble. On the other hand, an individual with $\lambda = 2.55$ would have a certainty equivalent of wealth of $987,286, and would therefore pay up to $12,714 to avoid the gamble.

This analysis suggests that an individual implementing an asset allocation similar to the declining-equity glidepaths featured in TDFs would pay, to avoid a 50–50 chance of winning or losing 10% of his capital, between 104% and 131% more on the retirement date than he would pay when being 25 years away from retirement.[14] That is, perhaps, the most intuitive way to interpret the range of risk aversion coefficients reported in Exhibit 4.

Other Glidepaths

The benchmark glidepath in Exhibit 1 is based on the TDFs offered by Vanguard, the largest provider of these products in early 2020. Other providers offer different glidepaths, some more aggressive than others but all sharing the same underlying strategy—that is, an asset allocation that becomes gradually more conservative as retirement approaches. Exhibit 5 illustrates these points.[15]

As the exhibit shows, the TDFs offered by these three companies feature declining-equity glidepaths, thus providing increasing downside protection as investors approach retirement; that is the most distinctive characteristic of all these products. Important to note, the exhibit also shows that, at each point along the glidepath, and particularly over the last 25 years before retirement, the allocation to stocks offered by these companies are not dramatically different from each other, nor are they dramatically different from those in Exhibit 1.[16]

This last point has an important implication: Although the results in Exhibit 4 were determined relative to the benchmark glidepath, based on Vanguard's TDFs, they apply more generally to the TDFs offered by other companies. In other words, the analysis here suggests that the somewhat different glidepaths offered by TDF providers satisfy the demand for increasing downside protection as investors approach retirement, which stems from investors' increase in risk aversion, particularly during the last 25 years of their accumulation period.

[12]Levy and Markowitz (1979) show that mean-variance behavior as formalized in Equation (1) is approximately equal to expected utility for several utility functions, including the power utility function.

[13]The certainty equivalent of wealth (W_c) is given by $W_c = \{1 + (1 - \lambda)\cdot E[U(W)]\}^{[1/(1-\lambda)]}$, where $E[U(W)]$ denotes the expected utility of wealth.

[14]For $\lambda = 2.25$, $11,237/$5,513 − 1 = 104%; similarly, for $\lambda = 2.55$, $12,714/$5,513 − 1 = 131%.

[15]This exhibit is based on information provided by Fidelity Investments (2020).

[16]Of interest, relative to the other companies in the exhibit, as well as relative to Vanguard, BlackRock's TDFs start out as more aggressive and end up as more conservative.

EXHIBIT 5
Other Glidepaths: Equity Exposure

Company	45	40	35	30	25	20	15	10	5
BlackRock	98	98	98	98	95	88	78	68	56
Fidelity	90	90	90	90	90	90	83	68	59
State Street	90	90	90	90	88	84	78	71	62

Notes: Exhibit 5 shows the glidepath of target-date funds (TDFs) offered by BlackRock (LifePath Index Funds), Fidelity (Freedom Index Funds), and State Street Global Advisors (Target Date Retirement Pools) as of the end of 2019. The numbers in the top row indicate years away from retirement; the rest of the exhibit numbers indicate the allocation to stocks (in %) in the TDFs offered by each company. Based on Fidelity Investments (2020).

ASSESSMENT

TDFs are by far the most popular default option in defined contribution retirement plans. Their main characteristic is a declining-equity glidepath that exposes investors to an increasingly conservative asset allocation as they approach retirement. Given that it is clear that this strategy is suboptimal in terms of capital accumulation, it is interesting to explore why investors are attracted to these funds.

Survey evidence shows that investors approaching retirement have a strong preference for protection against losses over potential for growth. Furthermore, experimental evidence reveals that individuals get more risk averse as they age. These two closely intertwined facts seem to justify the declining-equity glidepaths that asset management companies have selected for their TDFs. They also beg the question of how much more risk averse investors would need to become during their accumulation period to select asset allocations similar to those featured in TDFs. That is the ultimate issue explored in this article.

The main finding of the study is that, to select asset allocations similar to those in standard glidepaths, investors would have to roughly double their risk aversion during the last 25 years of their accumulation period. More precisely, their risk aversion would have to increase from 1.10 when 25 years away from retirement to the 2.25–2.55 range at the time of retirement. All these risk aversion levels are consistent with previous estimates reported in the literature, as well as with commonly accepted values for asset allocation.

Finally, because most practitioners view utility and risk aversion as somewhat abstract and obscure concepts, some intuition is provided for risk aversion coefficients, as well as for their increase over the last 25 years of an individual's accumulation period found here. The results show that to avoid a 50–50 chance of winning or losing 10% of his capital, an individual would be willing to pay 131% more when his risk aversion is 2.55 (the value obtained when the individual retires) than when it is 1.10 (the value obtained when he is 25 years away from retirement).

In short, although it is clear that TDFs do not maximize (or even aim to maximize) the size of the retirement portfolio, it seems clear why they are so popular with investors. They seem to be consistent with an increase in risk aversion as investors age, and its corresponding demand for increasing downside protection as investors approach retirement.

ACKNOWLEDGMENTS

I thank Rob Juxon and Jack Rader for their comments. David Vila provided research assistance. The views expressed in this article and any errors that may remain are entirely my own.

REFERENCES

Albert, S., and J. Duffy. 2012. "Differences in Risk Aversion Between Young and Older Adults." *Neuroscience and Neuroeconomics* 1: 3–9.

Arnott, R., K. Sherrerd, and L. Wu. 2013. "The Glidepath Illusion … and Potential Solutions." *The Journal of Retirement* 1 (2): 13–28.

Basu, A., and M. Drew. 2009. "Portfolio Size Effect in Retirement Accounts: What Does It Imply for Lifecycle Asset Allocation Funds?" *The Journal of Portfolio Management* 35 (3): 61–72.

Baz, J., and H. Guo. 2017. "An Asset Allocation Primer: Connecting Markowitz, Kelly and Risk Parity." Pimco Quantitative Research, October 2017, 1–16.

Bodie, Z., R. Merton, and W. Samuelson. 1992. "Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model." *Journal of Economic Dynamics and Control* 16 (3–4): 427–449.

De Santiago, R., and J. Estrada. 2013. "Geometric Mean Maximization: Expected, Observed, and Simulated Performance." *The Journal of Investing* 22 (2): 106–119.

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

Donaldson, S., F. Kinniry, B. Scott, T. Dinucci, and E. Cilla. 2019. "Vanguard's Approach to Target-Date Funds." Vanguard Research, March 2019.

Estrada, J. 2010. "Geometric Mean Maximization: An Overlooked Portfolio Approach?" *The Journal of Investing* 19 (4): 134–147.

——. 2013. "Stocks, Bonds, Risk, and the Holding Period: An International Perspective." *The Journal of Wealth Management* 16 (2): 25–44.

——. 2014. "The Glidepath Illusion: An International Perspective." *The Journal of Portfolio Management* 40 (4): 52–64.

Estrada, J., and M. Kritzman. 2019. "Toward Determining the Optimal Investment Strategy for Retirement." *The Journal of Retirement* 7 (1): 35–42.

Fidelity Investments. 2020. "Target Date Evaluation. How Fidelity Freedom Index Funds Compare on Glidepath, Performance, and Fees." https://institutional.fidelity.com/app/proxy/content?literatureURL=/9887468.PDF.

Gandelman, N., and R. Hernández-Murillo. 2014. "Risk Aversion at the Country Level." Working Paper 2014-005B, Federal Reserve Bank of St. Louis, MO, October 2014. https://files.stlouisfed.org/files/htdocs/wp/2014/2014-005.pdf.

Grubb, M., A. Tymula, S. Gilaie-Dotan, P. Glimcher, and I. Levy. 2016. "Neuroanatomy Accounts for Age-Related Changes in Risk Preferences." *Nature Communications* 7, Article 13822: 1–5.

ING Investment Management. 2012. "Participant Preferences in Target-Date Funds: Examining Perceptions and Expectations Among Target-Date Users and Non-Users." ING Retirement Research Institute, February 2012, 1–20.

Kurnianingsih, Y. A., S. K. Y. Sim, M. W. L. Chee, O. A. Mullette-Gillman. 2015. "Aging and Loss Decision Making: Increased Risk Aversion and Decreased Use of Maximizing Information, with Correlated Rationality and Value Maximization." *Frontiers in Human Neuroscience* 9, Article 280.

Latane, H. 1959. "Criteria for Choice Among Risky Ventures." *Journal of Political Economy* 67 (2): 144–155.

Levy, H., and H. Markowitz. 1979. "Approximating Expected Utility by a Function of Mean and Variance." *American Economic Review* 69 (3): 308–317.

Mladina, P., and C. Grant. 2019. "Glide Paths Based on a Retirement Goal and Depleting Human Capital." *The Journal of Investing* 28 (1): 8–16.

Thomas, P. 2016. "Measuring Risk Aversion: The Challenge." *Measurement* 79 (February): 285–301.

To order reprints of this article, please contact David Rowe at d.rowe@pageantmedia.com or 646-891-2157.

ADDITIONAL READING

The Glidepath Illusion … and Potential Solutions

Robert Arnott, Katrina Sherrerd, and Lillian Wu
The Journal of Retirement
https://jor.pm-research.com/content/1/2/13

ABSTRACT: *Target-date investment strategies purport to meet the two primary objectives of any retirement savings program: maximizing the real value of investors' nest eggs while minimizing uncertainty around prospective income in retirement. The authors demonstrate that the classic glidepath approach to retirement investing—moving from equity-centric to bond-centric investing as we age—does not meet these objectives.*

The authors summarize the flaws in traditional glidepath implementation and explore illustrative changes to the rules-based, mechanistic solution for retirement planning that can improve the expected outcome for investors, using simulations to test alternatives. Their findings show that, even with simple rules-based approaches, there are better ways to achieve our financial objectives for retirement.

Toward Determining the Optimal Investment Strategy for Retirement

Javier Estrada and Mark Kritzman
The Journal of Retirement
https://jor.pm-research.com/content/early/2019/06/28/jor.2019.1.052

ABSTRACT: *Investors who are about to retire are first and foremost concerned with supporting their spending needs throughout retirement. But they also derive satisfaction from growing their wealth beyond*

what is needed to support consumption in order to leave a bequest to their heirs or chosen charities. The predominant metric for evaluating retirement investment strategies is the failure rate. However, it fails to distinguish between strategies that fail early in retirement from those that fail near the end of retirement, and it fails to account for potential bequests. To overcome these shortcomings the authors propose a new metric, the coverage ratio, which is more comprehensive and informative than the failure rate. In addition, they propose a utility function to evaluate the coverage ratio, which penalizes shortfalls more than it rewards surpluses. Finally, the authors use their proposed framework to determine the optimal allocation to stocks and bonds using historical and simulated returns.

Glide Paths Based on a Retirement Goal and Depleting Human Capital

Peter Mladina and Charles Grant

The Journal of Investing
https://joi.pm-research.com/content/28/1/8

ABSTRACT: *The retirement goals of many Americans are underfunded. The problem is compounded by the complexity of self-managing distribution portfolios, particularly as DC plans replace DB plans. We believe most retirement glide paths are satisfactory but suboptimal solutions. We introduce a glide path of financial assets over the life cycle based on a retirement goal and depleting human capital. The method is anchored to the foundational principles of intertemporal portfolio theory while borrowing heavily from goals-based asset allocation. The result is a dynamic asset allocation over the life cycle that is a function of critical input variables relevant to retirement planning such as retirement savings, retirement consumption and risk aversion. The glide path can be customized to individuals, or semi-customized to discrete subpopulations of DC plan participants.*