

# Characteristics and Performance of Target Date Funds in the United States

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## SUMMARY

Target date funds (TDFs) are generally mutual funds that hold a diversified mix of stocks, bonds, and other investments. They are designed for individuals with a particular retirement date in mind—the “target date” or target year. Over time, TDF holdings automatically shift toward relatively safe assets. TDFs are rapidly gaining popularity, especially in defined contribution plans, and managed almost a trillion dollars at the end of 2016. This study characterizes the TDF landscape and analyzes the expenses, asset allocation, and (risk-adjusted) performance of TDFs.

We find that, in the aggregate, TDFs live up to their objectives of diversification and gradual reduction of exposure to risk. As expected, their rates of return move largely in tandem with those of domestic and international stocks, and fluctuations in valuations are more muted for TDFs that are close to or have passed their target year. Indeed, funds with more remote target years fared worse during the Great Recession. They also took longer to recover: funds with a 2035 or later target year on average took 4.9 years to climb back to their pre-Recession highs, compared with 3.0 years for pre-2020 funds.

There are large differences among TDFs, even among TDFs with the same target year. Adjusted for risk, we find large differences in rates of return, which are only partially explained by funds’ expense ratios. Also, a fund’s target year is not necessarily indicative of the extent to which it tolerates risk. For example, the returns of some 2030 funds were more volatile than those of some 2020 funds. We suggest an easy-to-calculate relative volatility metric that may better capture a fund’s risk tolerance than target year alone.

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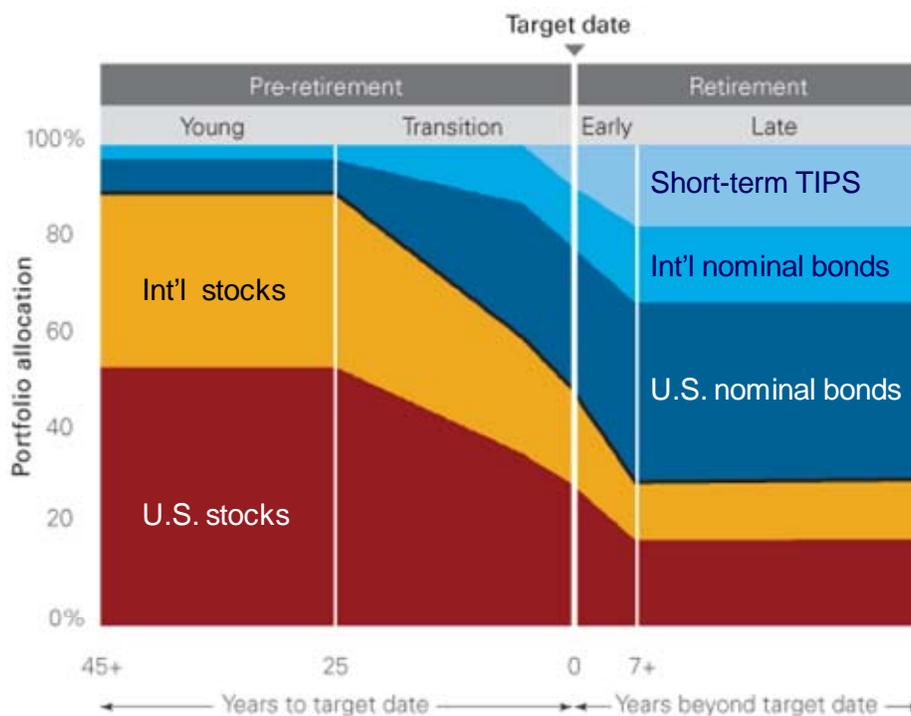
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## 1. INTRODUCTION

Target date funds (TDFs) are generally mutual funds that hold a diversified mix of stocks, bonds, and other investments. TDFs are designed to be long-term investments for individuals with a particular retirement date in mind (i.e., the “target date” or target year). As would be suggested by generally accepted investment principles, over time the asset mix gradually and automatically shifts to be more conservative as the target year approaches and passes. Typically, the assets in a TDF shift over time from a large exposure to stocks in the beginning to a mix weighted more toward bonds later on. The projected shift in asset allocation is referred to as the “glide path” of a TDF—see Figure 1 for an illustration of a glide path before and after the target date.

**Figure 1. Illustrative Glide Path of Target Date Funds**



Source: Vanguard

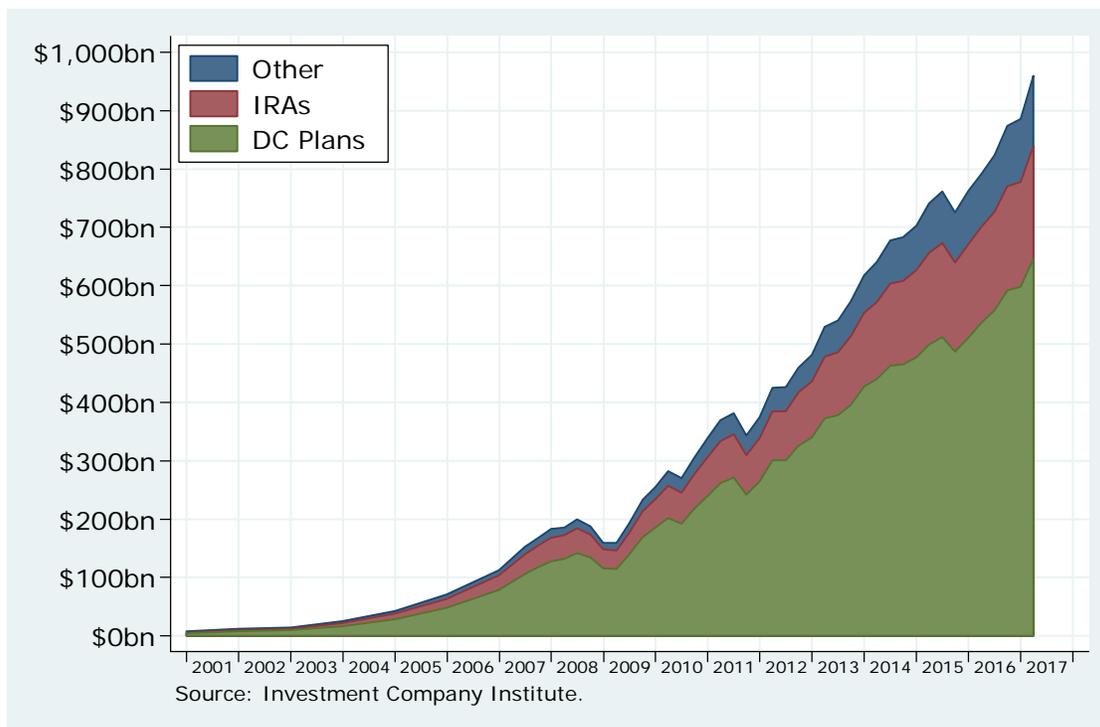
Having emerged in the 1990s, TDFs are a relatively new type of investment vehicle. Following a 2007 Department of Labor (DOL) regulation which designated TDFs as a qualified default investment alternative (QDIA),<sup>1</sup> many plan sponsors adopted TDFs as the default investment option for participants who do not actively choose an asset allocation. By 2014 TDFs were the QDIA for 86% of defined contribution (DC) plans.<sup>2</sup>

<sup>1</sup> “Default Investment Alternatives under Participant Directed Individual Account Plans.” Federal Register Vol. 72 (October 24, 2007), pp. 60452-60480.

<sup>2</sup> Towers Watson. 2015. “Are managed accounts a better QDIA?” Available at <https://www.towerswatson.com/en-US/Insights/IC-Types/Technical-Regulatory/2015/05/are-managed-accounts-a-better-qdia>.

Virtually non-existent in the year 2000, assets invested in TDFs rose to \$959 billion at the end of the first quarter of 2017. Of these assets, \$646 billion (67%) were held in DC plans, \$193 billion (20%) in IRAs, and \$121 billion (13%) in other accounts (Figure 2).<sup>3</sup> These figures exclude assets in TDFs that are not publicly traded.

**Figure 2. Target Date Fund Assets, by Sales Channel (2001-2017)**



At the end of the first quarter of 2017, TDFs accounted for approximately 9.5% of DC assets and 2.4% of IRA assets in the United States.<sup>4</sup> TDF assets under management have been growing much faster than other assets in DC plans and IRAs, i.e., the market share of TDFs has been growing.

The remainder of this document is organized as follows. We first summarize prior literature and our theoretical perspective. Section 3 discusses the data. Section 4 presents our findings on asset allocations, expense ratios, raw performance of TDFs as a group over time, the volatility of TDF returns, and risk-adjusted performance differences across TDFs. Arguing that target year alone is of limited value to gauge the risk tolerance of a fund's asset allocation profile, Section 5 presents an alternative metric and illustrates some of its features. Section 6 concludes.

<sup>3</sup> Investment Company Institute (ICI). "The U.S. Retirement Market, First Quarter 2017." June 22, 2017. [https://www.ici.org/research/stats/retirement/ret\\_17\\_q1](https://www.ici.org/research/stats/retirement/ret_17_q1); Figure 2 is based on Table 21 in [http://www.ici.org/info/ret\\_17\\_q1\\_data.xls](http://www.ici.org/info/ret_17_q1_data.xls).

<sup>4</sup> See footnote 3.

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## 2. PRIOR LITERATURE AND THEORETICAL PERSPECTIVE

TDFs are typically funds of funds, that is, their assets are invested in other mutual funds. The expenses of a TDF therefore include both the expenses of the underlying funds and a “wrap fee” for administering the TDF itself, which includes designing a certain allocation pattern, reallocating the assets over time, and recordkeeping. In principle, investors with access to the underlying funds can invest directly into those funds to circumvent the TDF and avoid the wrap fee. However, Elton, Gruber, de Souza, and Blake (2015) found that such a do-it-yourself approach is unlikely to reduce overall investment expenses.<sup>5</sup> They found that the additional expenses charged by TDFs are largely offset by the low-cost share classes they hold, which are not normally available to retail investors. Also, the do-it-yourself investor would incur additional transaction costs for purchasing multiple funds and for portfolio rebalancing. Separately, they found that TDFs invest in, on average, 17 underlying funds, including specialized funds of real estate and commodities, which have become increasingly prevalent in TDFs in recent years. Finally, they found no evidence that actively managed TDFs outperform passive TDFs.

The Capital Asset Pricing Model (CAPM) guides our thinking about TDFs. It explains how investors can diversify their asset holdings to minimize risk (volatility) for a given expected rate of return.<sup>6</sup> The idea is that the price of each asset is subject to certain random fluctuations. The fluctuations in the prices of these assets have an idiosyncratic component and a component that is correlated with prices of other assets. Investors can exploit the latter fluctuations to “diversify away” some of the volatility of individual assets.

As an illustration of CAPM consider Figure 3. The red dots represent the expected risks and returns (derived from historical data) of individual assets, which may include stocks or bonds of individual companies, mutual funds, real estate, commodities, art, or other investment assets. Portfolios of such individual assets can be constructed such that expected risks are minimized for a given expected rate of return, or expected return is maximized for a given expected risk. Those portfolios form an “efficient frontier.” Separately, a risk-free asset is assumed to be available.<sup>7</sup> The “security market line” is defined as the straight line that crosses the vertical axis at the return of the risk-free asset and is tangential to the efficient frontier. It represents the set of portfolios that minimize expected risk for any given expected rate of return in the presence of a risk-free asset in the portfolio. Given that expected risk is minimized, investors will want to choose portfolios along this line. Which portfolio is chosen will depend on the characteristics of the investor, such as his risk aversion and time preference.

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<sup>5</sup> Edwin J. Elton, Martin J. Gruber, Andre de Souza, and Christopher R. Blake. 2015. “Target Date Funds: Characteristics and Performance.” *The Review of Asset Pricing Studies* 5(2): 254-272. A summary of this article was published as “Target Date Funds: What’s under the Hood?” Center for Retirement Research at Boston College, Issue Brief 17-2, January 2017.

<sup>6</sup> E.g., Edwin J. Elton, Martin J. Gruber, Stephen J. Brown, and William N. Goetzmann. 2007. *Modern Portfolio Theory and Investment Analysis*. John Wiley & Sons, Inc., 7<sup>th</sup> Edition.

<sup>7</sup> Short-term Treasury Bills are often used as a proxy for a risk-free asset.

**Figure 3. Capital Asset Pricing Model**

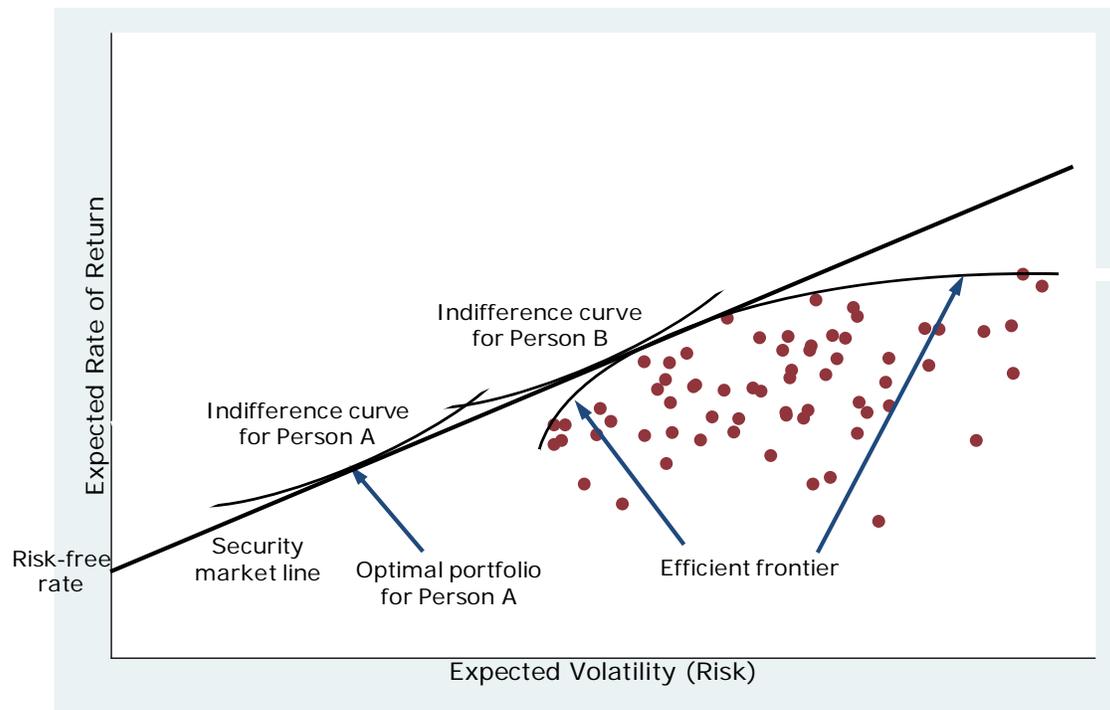


Figure 3 also depicts indifference curves for two individuals. Indifference curves represent the risk/return trade-offs among which a person is indifferent because they provide the same level of utility. Indifference curves for two illustrative people (Person A and Person B) are shown, namely the curves that touch the security market line. The tangent point represents that person's optimal portfolio. The optimal portfolio of Person A corresponds to lower expected risk and lower expected return than the optimal portfolio for Person B. The indifference curves and, therefore, optimal portfolios of the two individuals differ; a common interpretation is that person B has a longer investment horizon than Person A, but differences may also arise from differences in innate risk aversion.

Each red dot in Figure 3 illustrates a financial asset, and conversely every financial asset can be represented with a red dot at its risk-return coordinates. Applied to TDFs, the Capital Asset Pricing Model suggests that the red dots corresponding to optimal TDF portfolios lie on the security market line. For example, Person B may be relatively young, have a long investment horizon which permits him to absorb short-term asset price fluctuations, and may be well served by a fund with expected risk/return that is toward the north-east of a fund that serves Person A, who may have the same innate risk-aversion as Person B, but who is older and has a shorter investment horizon. In other words, the risk-return coordinates of TDFs with a remote target date should lie toward the north-east of those of funds with a target year in the past or near future.

### 3. DATA

The primary data source for this study is Morningstar through its Morningstar Direct product.<sup>8</sup> From this source we identified target date funds and obtained daily rates of return, monthly assets under management, and such other fund-level information as target year, expense ratios, asset allocation, etc. We extracted historical information on rates of return and assets starting in the year 2000 or the inception date of a fund, whichever came later.

In addition, this study relies on data from the Thrift Savings Plan (TSP), a DC plan that serves many federal government employees. Among other fund options, the TSP offers TDFs under the name “L Funds” (Lifecycle funds).<sup>9</sup> While its funds are not publicly traded, the TSP publishes daily share prices.

The Morningstar data contain 3,465 target date funds that were active for some period during 2000-2016, including funds with a target date in the past and including funds that are no longer active.<sup>10</sup> The TSP adds another six funds, for a total of 3,471 funds. We exclude 62 funds for which no usable information was available on rates of return or assets. Our analysis is based on the remaining 3,409 funds. By the end of 2016, 590 funds had been liquidated, 344 had merged with other funds, and the remaining 2,475 were still active.

As is typical for mutual funds, there may be multiple share classes for each fund, each with a unique ticker symbol.<sup>11</sup> For purposes of this document, each class counts as a fund. On average, funds are marketed with approximately four share classes. Also, TDFs are typically developed in families that include funds for various target years. For example, a firm may offer funds with a target year in the past (“retirement income fund”) and for 2010, 2020, 2030, 2040, 2050, and 2060. Many firms offer TDFs in 5-year target increments. By the end of 2016, 41 firms offered one or more TDF families.

Figure 4 shows the number of TDFs by year, including the number that were new or ceased operations in each year. The number of TDFs grew from just 43 at the end of 2000 to 1,564 by the end of 2008 and to 2,475 by the end of 2016.

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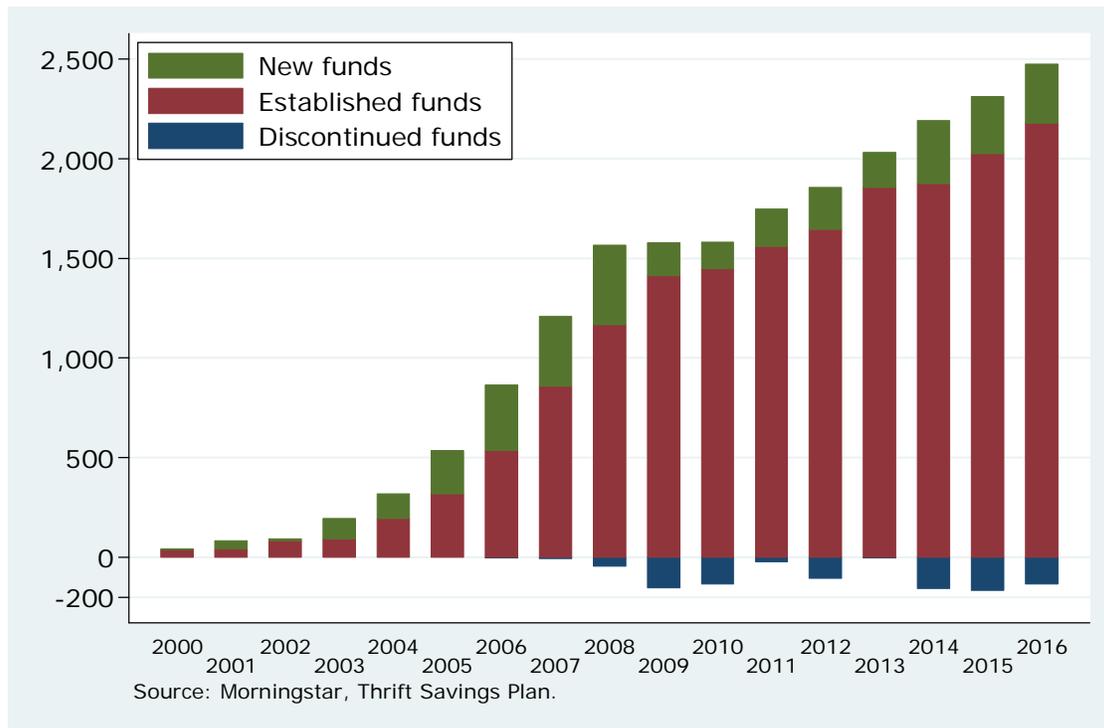
<sup>8</sup> <http://www.morningstar.com/company/direct>.

<sup>9</sup> <https://www.tsp.gov/InvestmentFunds/FundOptions/index.html>

<sup>10</sup> Target dates in the past include 2000, 2005, 2010, and 2015. Once a fund with a target year in the past reaches its most conservative asset allocation, fund managers commonly merge that fund with their “retirement income” fund. As used in this document, funds with a target date in the past include retirement income funds and funds with target years up to 2015.

<sup>11</sup> A single mutual fund, with one portfolio of underlying assets, may offer more than one “class” of its shares to investors. The main difference between the classes is that the mutual fund charges different fees and expenses depending on the class. See, for example, <https://www.sec.gov/fast-answers/answersmfclasshtm.html>.

**Figure 4. Number of Target Date Funds That Were Introduced, Discontinued, or Continued to Be Active, by Year**



## 4. ANALYSIS

This section first presents various cross-sectional statistics for active funds as of the end of 2016 and then discusses time series since approximately 2000. The time series analysis incorporates funds that are no longer active.

### Assets under Management

Table 1 shows the number of active funds and their assets under management at the end of 2016, by target year. Funds with target years at whole decennia (2020, 2030, etc.) are the most common, but many funds feature target years in between whole decennia (2015, 2025, etc.). At present, the most distant target year is 2060. Most assets are invested in 2020-2040 funds.

**Table 1. Number of Target Date Funds, by Target Year (12/31/2016)**

| Target year  | Number of funds | Assets under management (\$bn) |
|--------------|-----------------|--------------------------------|
| Pre-2015     | 303             | 65.5                           |
| 2015         | 144             | 58.6                           |
| 2020         | 250             | 167.0                          |
| 2025         | 218             | 134.8                          |
| 2030         | 250             | 169.5                          |
| 2035         | 218             | 105.4                          |
| 2040         | 250             | 123.3                          |
| 2045         | 218             | 65.9                           |
| 2050         | 243             | 55.9                           |
| 2055         | 216             | 17.2                           |
| 2060         | 165             | 2.8                            |
| <b>Total</b> | <b>2,475</b>    | <b>965.8</b>                   |

Source: Morningstar, Thrift Savings Plan.

Table 2 shows TDF assets under management of the largest target date fund managers. By the end of 2016, total TDF assets amounted to \$966 billion, including \$85.4 billion invested in TDFs of the Thrift Savings Plan (which was excluded from Figure 2 above).

**Table 2. TDF Assets under Management by the Largest TDF Firms (12/31/2016)**

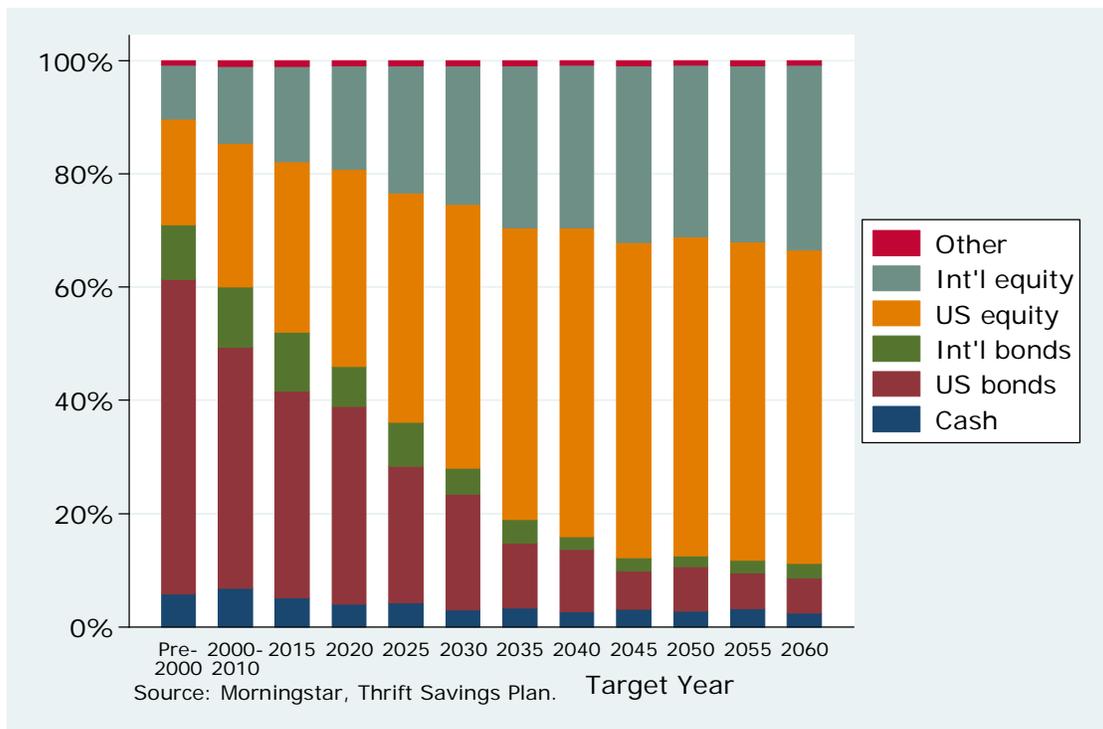
| Firm                         | Assets (\$bn) |
|------------------------------|---------------|
| Vanguard                     | 280.3         |
| Fidelity Investments         | 192.9         |
| T. Rowe Price                | 148.0         |
| Thrift Savings Plan          | 85.4          |
| American Funds               | 53.6          |
| JPMorgan                     | 44.8          |
| TIAA-CREF Asset Management   | 31.3          |
| Principal Funds              | 26.1          |
| American Century Investments | 17.0          |
| John Hancock                 | 16.3          |
| All others                   | 70.0          |
| <b>Total</b>                 | <b>965.8</b>  |

Source: Morningstar and Thrift Savings Plan.

## Asset Allocation

Figure 5 shows average asset allocations for TDFs, by target year. Approximately 99% of TDF portfolios are invested in equity, bonds, and cash (equivalents); the remaining 1% includes such "other" assets as real estate and commodities. Unless noted otherwise, summary statistics in the remainder of this document are weighted by assets under management. Consistent with our expectations, exposure to stocks increases with target year, whereas bond holdings decrease correspondingly.

**Figure 5. Average Asset Allocation of TDFs, by Target Year (2016)**



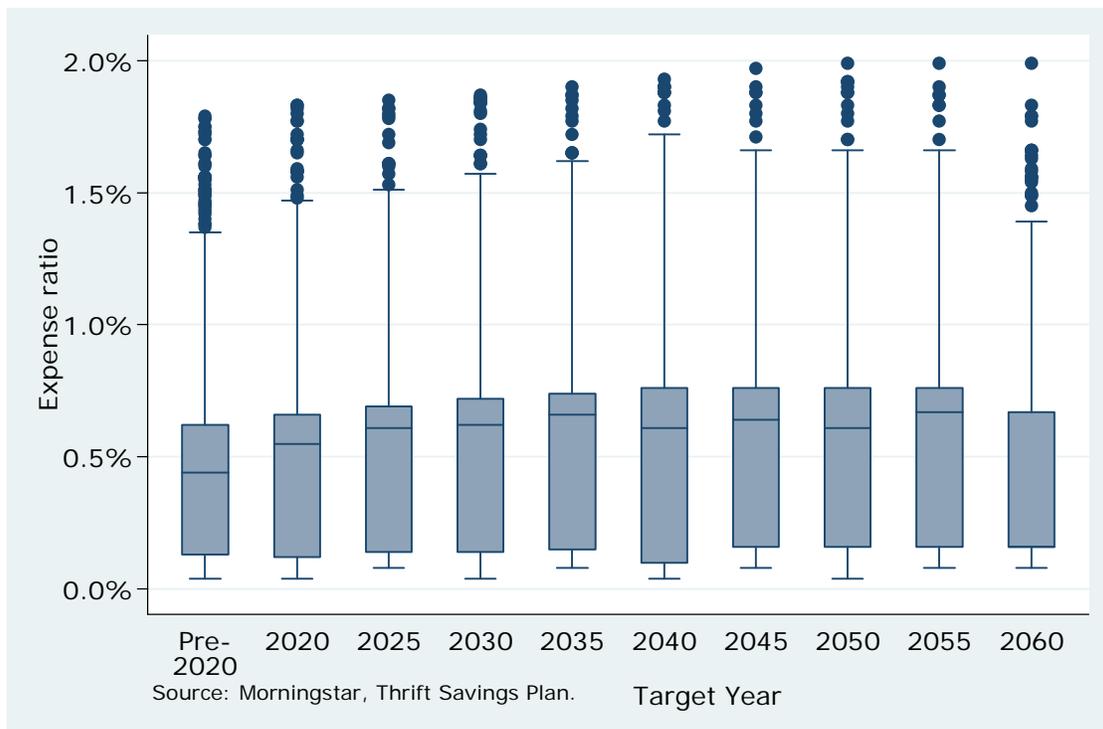
## Expense Ratios

TDF managers annually charge a percentage of assets for their services, known as the expense ratio. Each fund publishes a “gross” expense ratio in its prospectus, but in some cases fees are reduced or waived. We summarize “net” expense ratios, which average the expense ratios that are actually charged.<sup>12</sup> They include both wrap fees and expenses of underlying funds.

Figure 6 shows the distribution of net expense ratios, by target year, at the end of 2016. The boxes in Figure 6 represent the 25<sup>th</sup> percentile (bottom), median (middle line), and 75<sup>th</sup> percentile (top); the whiskers identify adjacent values;<sup>13</sup> and the dots single-fund outliers.

<sup>12</sup> Unlike gross expense ratios, net expense ratios exclude interest and dividends on borrowed securities. We found some suggestive evidence that such interest and dividends can be substantial for certain TDFs that reported negative cash holdings.

<sup>13</sup> The upper adjacent value is the highest data point that is not greater than the 75th percentile plus 150% of the interquartile range. The lower adjacent value is the lowest data point that is not less than the 25th percentile minus 150% of the interquartile range.

**Figure 6. Distribution of Funds' Net Expense Ratios, by Target Year (2016)**

With the exception of 2060 funds, median net expense ratios generally increased with target year, from 0.44% for pre-2020 funds to 0.67% for 2055 funds. The median expense ratio among 2060 funds was much lower at 0.16%, because a single, relatively inexpensive fund accounted for almost one-half of all assets in that category. (The line for median expense ratio for 2060 funds is not visible because it coincides with the 25<sup>th</sup> percentile.) The overall median expense ratio was 0.57% at the end of 2016.

Table 3 provides additional detail on net expense ratios. While the overall median was 0.57%, one-in-four TDFs charged at least 0.72%, and one-in-ten charged 0.88% or more. As discussed above, these net expense ratios reflect average discounts; the overall median *gross* expense ratio was 0.59%.

**Table 3. Distribution of Funds' Net Expense Ratios, by Target Year (2016)**

| Target Year | Percentiles |       |       |       |       |       |       | Average |
|-------------|-------------|-------|-------|-------|-------|-------|-------|---------|
|             | 1           | 10    | 25    | 50    | 75    | 90    | 99    |         |
| Pre-2020    | 0.04%       | 0.09% | 0.13% | 0.44% | 0.62% | 0.79% | 1.25% | 0.41%   |
| 2020        | 0.04%       | 0.04% | 0.12% | 0.55% | 0.66% | 0.81% | 1.26% | 0.43%   |
| 2025        | 0.10%       | 0.10% | 0.14% | 0.61% | 0.69% | 0.91% | 1.35% | 0.49%   |
| 2030        | 0.04%       | 0.04% | 0.14% | 0.62% | 0.72% | 0.87% | 1.30% | 0.47%   |
| 2035        | 0.10%       | 0.10% | 0.15% | 0.66% | 0.74% | 0.94% | 1.40% | 0.52%   |
| 2040        | 0.04%       | 0.04% | 0.10% | 0.61% | 0.76% | 0.90% | 1.33% | 0.48%   |
| 2045        | 0.10%       | 0.10% | 0.16% | 0.64% | 0.76% | 0.97% | 1.47% | 0.52%   |
| 2050        | 0.04%       | 0.04% | 0.16% | 0.61% | 0.76% | 0.90% | 1.48% | 0.49%   |
| 2055        | 0.10%       | 0.10% | 0.16% | 0.67% | 0.76% | 1.01% | 1.54% | 0.55%   |
| 2060        | 0.10%       | 0.10% | 0.16% | 0.16% | 0.67% | 0.78% | 1.56% | 0.38%   |
| All         | 0.04%       | 0.10% | 0.14% | 0.57% | 0.72% | 0.88% | 1.35% | 0.47%   |

Source: Morningstar, Thrift Savings Plan.

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The spread in expense ratios among TDFs appears to be slightly narrower than among equity funds and bond funds.<sup>14</sup>

## Rates of Return

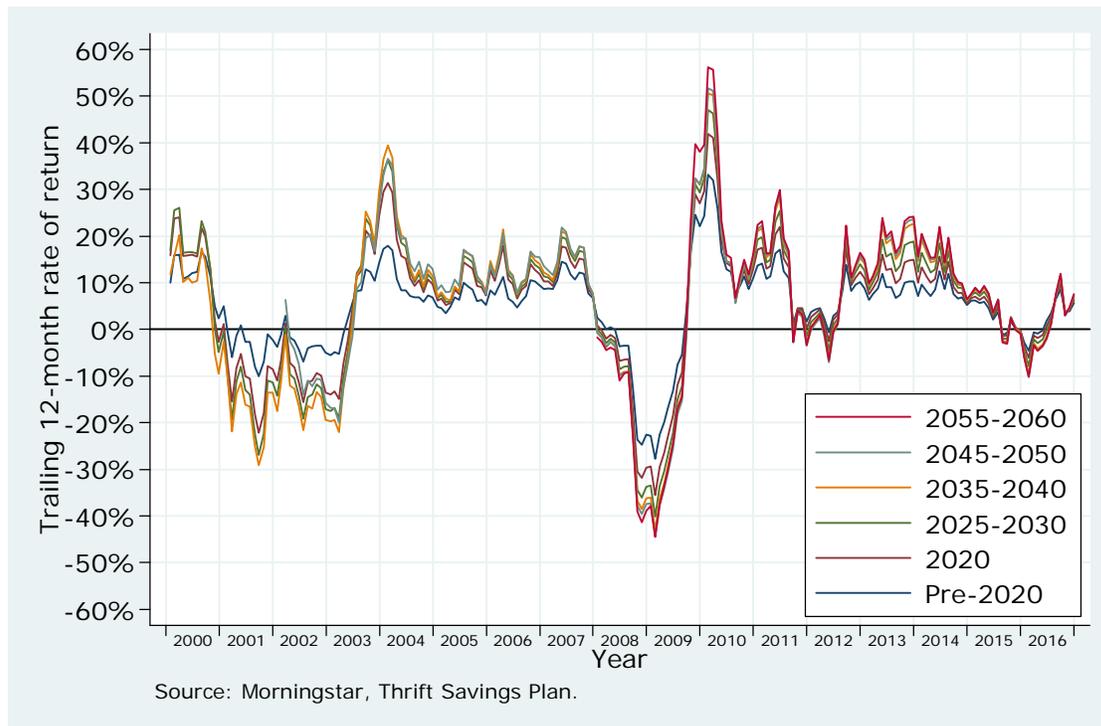
Figure 7 shows one-year trailing average rates of return for 2000-2016, by target year.<sup>15</sup> These averages were calculated over all TDFs that were active at the time, including TDFs that have since ceased operating. The annual returns for various vintages tend to rise and fall in tandem and vary substantially. Consistent with differences in exposure to equity, the more distant the target year, the more annual returns fluctuated. For example, 2055-2060 funds performed worse than other funds in 2008 (when the S&P 500 Index lost 38%) and better in 2009 (when the S&P 500 Index gained 23%). Conversely, the performance of funds in the “Pre-2020” category (consisting of retirement income funds and funds with target years up to 2015) was more muted: relatively good in years with generally poor aggregate results and relatively poor in years with generally good results.

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<sup>14</sup> Investment Company Institute (ICI). “Trends in the Expenses and Fees of Funds, 2016.” ICI Research Perspective 23(3), March 2017. Available at <https://www.ici.org/pdf/per23-03.pdf>. ICI documented a spread in expense ratios between the 90<sup>th</sup> and 10<sup>th</sup> percentile of 1.36% among equity mutual funds and 1.18% among bond mutual funds. The figures are not comparable to those in Table 3, because those of ICI are not asset-weighted. Unweighted, the 90<sup>th</sup> and 10<sup>th</sup> percentiles of expense ratios of TDFs were 1.44% and 0.37%, respectively, i.e., the spread was 1.07%.

<sup>15</sup> Trailing one-year average rates of return were calculated as follows. Consider 2020 funds. For each individual day, we first calculated the average daily rate of return of all 2020 funds that traded on that day. Since funds are launched and discontinued at different times, the mix of funds contributing to daily averages varies. Next, we compounded the average rates of return for all trading days over the preceding year. This resulted in one-year trailing rates of return for every day. Figure 7 graphs those rates for 12 days per year, namely for the last trading day of every month. The teal line for 2045-2050 funds starts in March 2002 because the first 2045-2050 funds started trading in March 2001. Similarly, the red line for 2055-2060 funds starts in January 2008 because the first 2055-2060 funds started trading in January 2007.

**Figure 7. One-Year Trailing Average Rates of Return for 2000-2016, by Target Year**



The National Bureau of Economic Research (NBER) defined the “Great Recession” as from December 2007 to June 2009.<sup>16</sup> According to the NBER, the average business cycle since 1945 lasted roughly 70 months. Table 4 shows annualized rates of return for the 70 months around the Great Recession: 26 months immediately before, 18 months during, and 26 months immediately after the Great Recession. Annualized average rates of return of TDFs are listed in the top panel and those of various benchmark indices in the bottom panel.

<sup>16</sup> See <http://www.nber.org/cycles.html>. The downturn in equity prices occurred slightly earlier. For example, the S&P 500 Total Return Index peaked on October 9, 2007 and had lost 55% of its value by March 9, 2009.

**Table 4. Annualized Rates of Return of TDFs and Selected Benchmarks Before, During, and After the Great Recession**

|                      | Oct 2005 to<br>Dec 2007 | Dec 2007 to<br>Jun 2009 | Jun 2009 to<br>Aug 2011 | Total |
|----------------------|-------------------------|-------------------------|-------------------------|-------|
| Pre-2020 funds       | 9.1%                    | -11.7%                  | 12.2%                   | 4.4%  |
| 2020 funds           | 11.4%                   | -16.6%                  | 13.7%                   | 4.2%  |
| 2025-2030 funds      | 12.4%                   | -19.8%                  | 14.6%                   | 3.8%  |
| 2035-2040 funds      | 13.1%                   | -21.9%                  | 15.0%                   | 3.5%  |
| 2045-2050 funds      | 13.3%                   | -22.9%                  | 15.1%                   | 3.3%  |
| 2055-2060 funds      |                         | -22.1%                  | 16.1%                   | -0.9% |
| US equity index      | 12.5%                   | -23.6%                  | 15.9%                   | 3.0%  |
| Foreign equity index | 19.9%                   | -22.8%                  | 11.8%                   | 4.3%  |
| US bonds index       | 5.1%                    | 4.9%                    | 8.3%                    | 6.2%  |

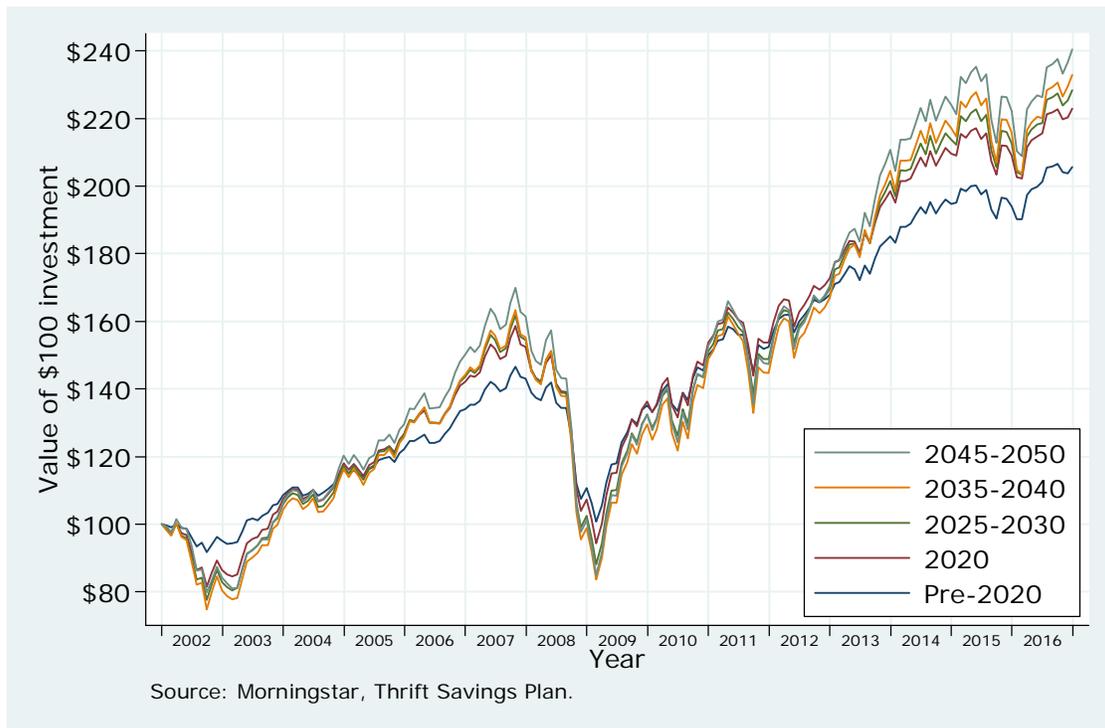
Source: Morningstar, Thrift Savings Plan.

Note: Rates of return calculated from day 16 of the start month through day 15 of the end month. US equity index is the Fama-French equity market benchmark; Foreign equity index is MSCI ACWI Ex-US Net Total Return; and US bonds index is Bloomberg Barclays US Aggregate Bond Total Return.

Consistent with their high exposure to equity, 2045-2050 funds and other TDFs with a distant target year performed roughly in line with a weighted average of US and foreign equity indices. Their performance over the entire 70-month period was slightly worse than those indices, which is partly explained by the costs to operate TDFs. For example, 2045-2050 funds averaged 3.3% annually over the 70-month period, compared with 3.0% for a broad-based US equity index and 4.3% for foreign equities. Funds with a target year prior to 2020 performed better; they lost only about one-half of the losses of 2045-2050 funds during the Great Recession and averaged 4.4% over the entire period.

For young retirement savers, year-to-year fluctuations in returns—and even fluctuations over several years—matter less than long-term performance. To gauge long-term differences in rates of return, we present two additional calculations. Figure 8 shows the value of a hypothetical \$100 investment that was made at the end of 2001, by TDF category. Despite adverse market conditions in 2002, during the Great Recession, and in 2011, the portfolio values generally increased. As expected, the long-term results were more favorable for TDFs with more distant target years. For example, over the entire 15-year period, pre-2020 funds yielded 4.9% annually, 2020 funds 5.5%, 2025-2030 funds 5.7%, 2035-2040 funds 5.8%, and 2045-2050 funds 6.0%. While the pre-2020 category lost ground during periods of strong stock market returns, they tended to close the gap in adverse times, and their average performance after the first 10 years was virtually indistinguishable from that of more aggressive funds.

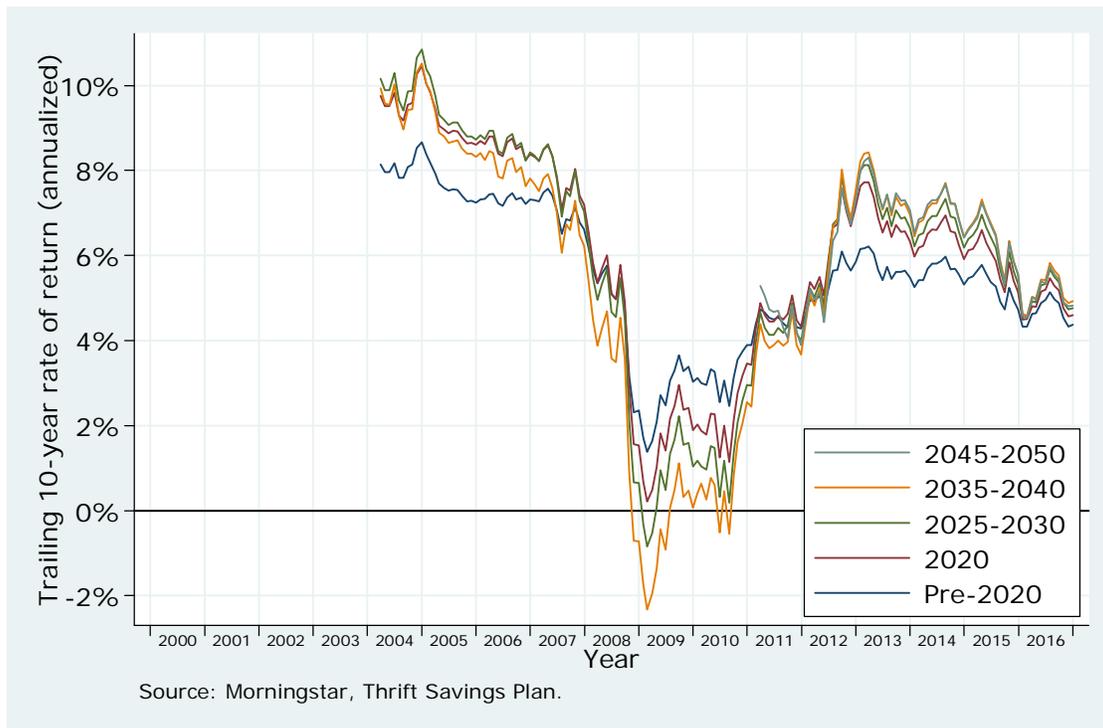
**Figure 8. Value of a \$100 TDF Investment Made at the End of 2001, by Target Year**



Before the Great Recession, the values of TDF investments peaked in October 2007. It took the average pre-2020 fund 3.0 years to climb back to its pre-Recession high, compared with 3.3 years for 2020 funds, 3.5 years for 2025-2030 funds, 4.9 years for 2035-2040 funds, and also 4.9 years for 2045-2050 funds. In other words, pre-2020 funds recovered faster than funds with a remote target year, which is consistent with the time horizon of the investors they serve.

Figure 9 demonstrates another perspective on long-term rates of returns of TDFs. It shows 10-year trailing average rates of return, converted into annualized rates. The vertical scale is more condensed than in the one-year version (Figure 7), but the same general pattern holds: more aggressive funds tend to do better when equity markets perform strongly and worse when they do not. The Great Recession had such severe effects on equity markets that it pushed even some 10-year returns below zero.

**Figure 9. 10-Year Trailing Average Rates of Return for 2000-2016, by Target Year (Annualized)**



## Risks and Returns

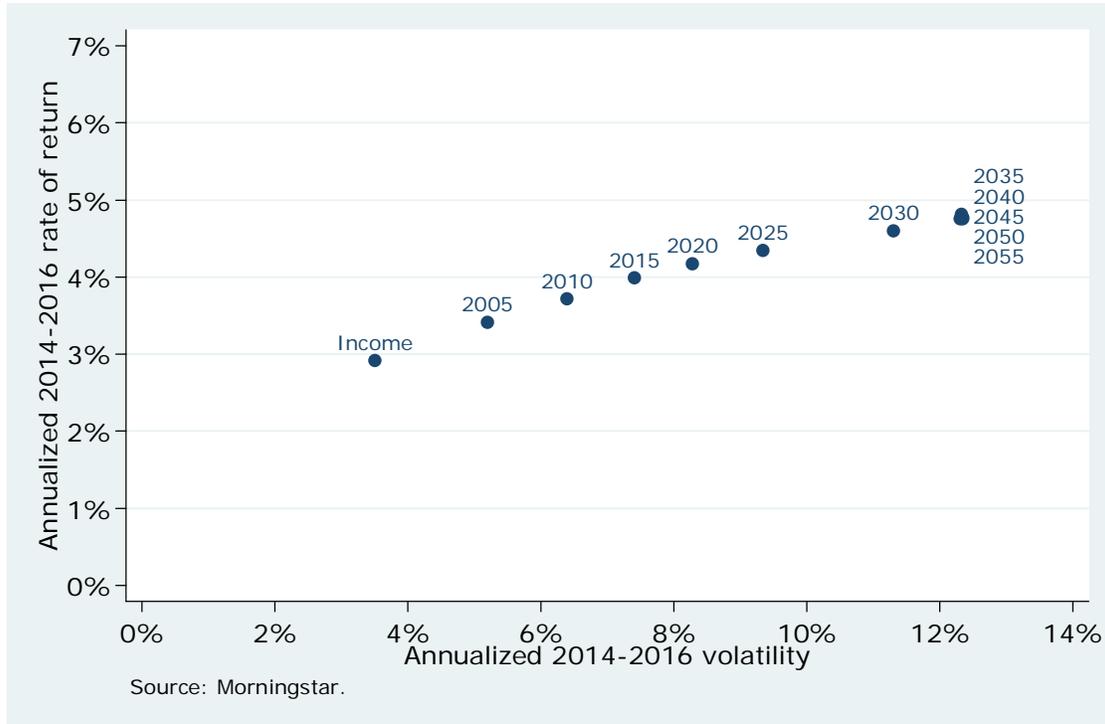
As explained above, CAPM predicts that the risk-return coordinates of well-diversified portfolios lie on a straight line, with more aggressive portfolios to the north-east of more conservative ones. For each individual TDF that was active throughout 2014-2016, we calculated annualized risks (volatility) and returns for the three-year period from 2014 to 2016.

Figure 10 plots the 2014-2016 risks and returns for all members of a certain TDF family. (All members of this family belong to the same share class.) This family consists of a retirement income fund and funds for target years 2005 through 2055, in five-year increments. The risk-return coordinates approximately line up as expected, with two observations worth making. First, the risks and returns of the 2035, 2040, 2045, 2050, and 2055 funds of this family are almost identical. Indeed, according to their prospectus, their asset allocations are very similar.<sup>17</sup> Second, the returns of 2030 and later funds appear to be slightly lower than as suggested by a straight line. A likely (partial) explanation lies in expense ratios. This fund family

<sup>17</sup> Volatility typically increases with exposure to equities, and around 90% of the assets of these 2035-2055 funds are invested in equities. Theoretically, a fund manager can adopt a leveraged strategy, i.e., borrow cash, invest more than 100% of the net fund assets in equities and other volatile assets, and move a funds' risk-return coordinates further to the north-east than the market portfolio. Indeed some funds report negative cash allocations, but negative values are not concentrated among funds with remote target years, and their volatility is generally in line with that of other funds in their category.

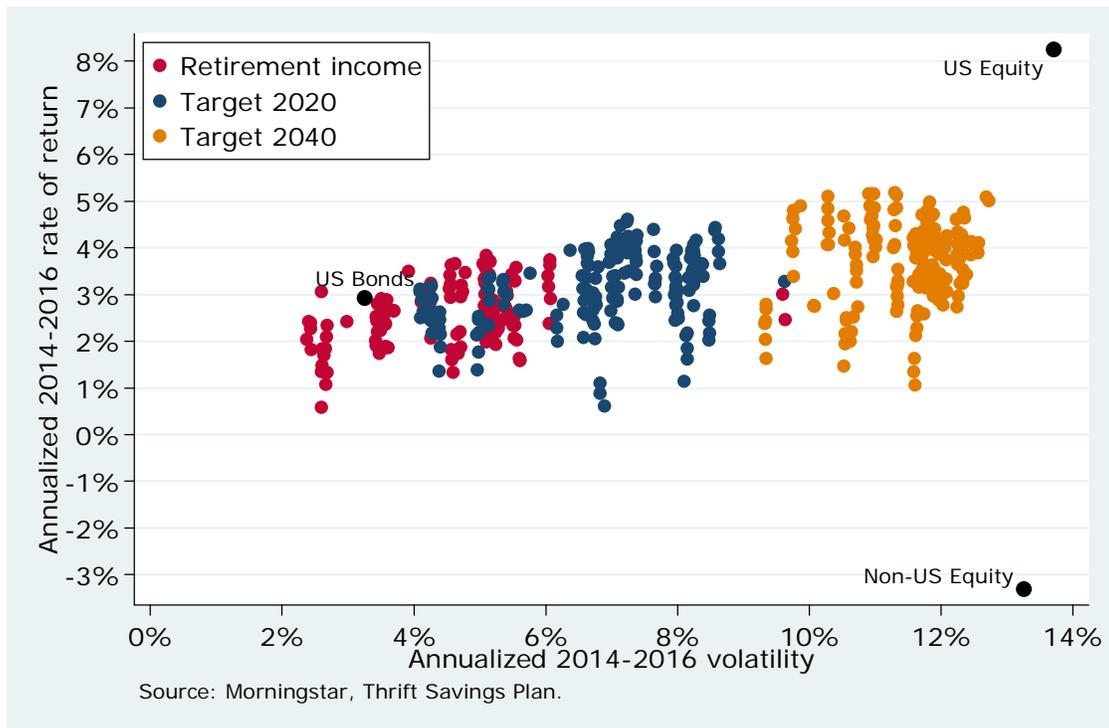
charges higher expense ratios for funds with more distant target years, ranging from 0.44% for the Income fund to 0.67% for funds with target years 2035 and later.

**Figure 10. Risks and Returns for Individual Funds in an Illustrative TDF Family (2014-2016)**



Similarly, Figure 11 shows the 2014-2016 risks and returns for all TDFs with target years before 2020 (red dots), 2020 (blue dots) and 2040 (orange dots). Each dot represents a fund. As expected, the more distant the target year, the higher the risks and returns were in 2014-2016. There is substantial overlap among fund categories—in particular, some 2020 funds have risk-return profiles that are very similar to those of retirement income (pre-2020) funds. In part, this reflects different philosophies across funds. Some funds aim to invest “to” retirement whereas others accept more volatility at the target year and invest “through” retirement. Clearly, target year alone is not a good indicator of risk tolerance. See Section 5 for a discussion of an alternative metric of a fund’s risk tolerance.

**Figure 11. Risks and Returns for Individual Funds with Target Years before 2020, 2020, and 2040 (2014-2016)**

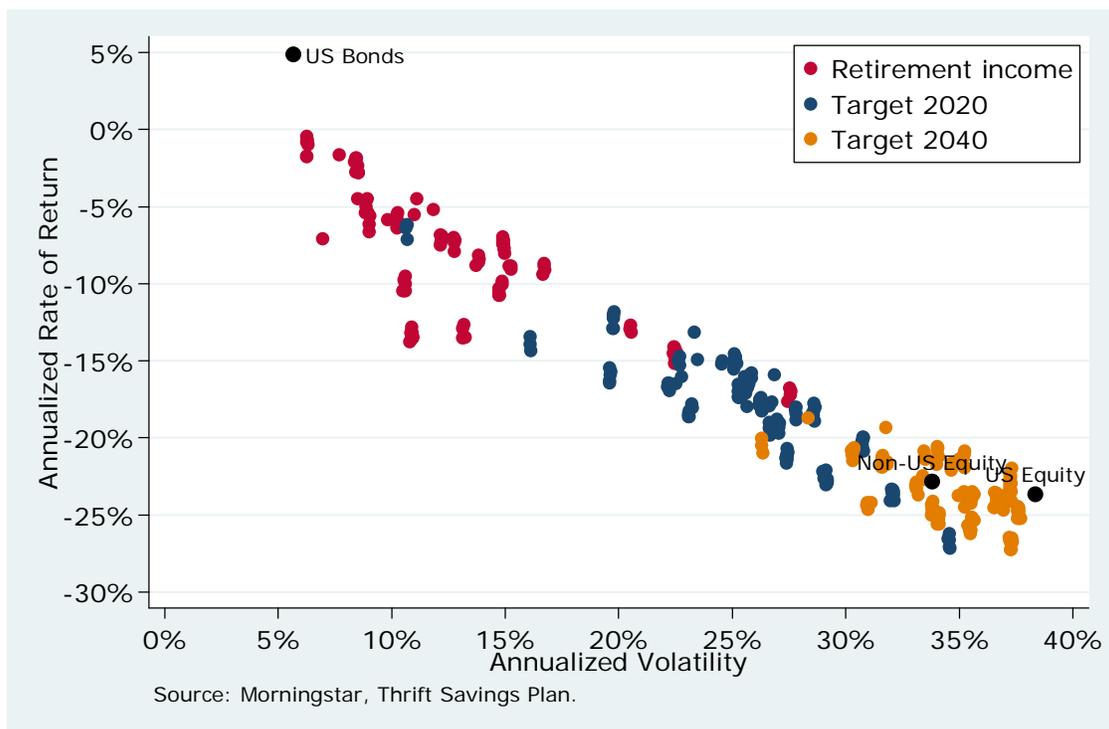


As discussed earlier, some firms offer multiple classes of their TDFs which differ primarily in their expenses. The volatility of funds is not affected by their expense ratios; only their net returns are. Indeed, series of dots aligned vertically tend to represent funds of the same firm but with different classes. For example, the four orange dots with a volatility of slightly over 9% differ only in their classes, with expense ratios ranging from 0.55% (Retirement Class) to 1.70% (C Class).

Superimposed on Figure 11 are the risk-return coordinates of three asset benchmarks defined in the note to Table 4 (page 12): US bonds, US equity, and non-US equity. International stocks had similar volatility as domestic stocks, but performed much worse in 2014-2016. The CAPM security market line (Figure 3, page 4) can be viewed as approximately the risk-return coordinates of portfolios with about four parts US equity, one part non-US equity, and varying parts of bonds and risk-free assets.

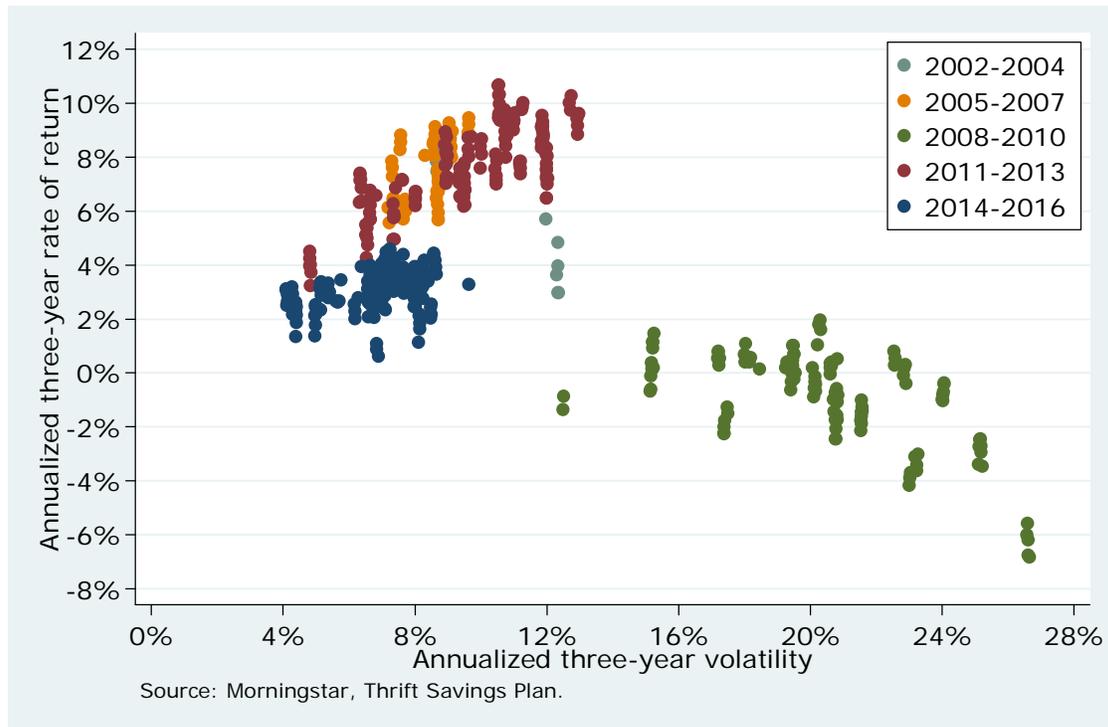
Figure 11 is consistent with the conventional wisdom that younger workers can tolerate more risk in exchange for higher returns. However, the pattern looks different in years with adverse equity market conditions, such as the period of the Great Recession from December 2007 through June 2009—see Figure 12. During that period, greater volatility was associated with lower rates of return, and the security market line was sloping downward.

**Figure 12. Risks and Returns for Individual Funds with Target Years before 2020, 2020, and 2040 (December 2007 through June 2009)**



To illustrate risks and returns over time, consider Figure 13, which depicts risks and returns for individual funds for different three-year periods. It is restricted to funds with a target year of 2020. The light-blue dots represent these TDFs for the 2002-2004 period; only a few funds were active throughout that period. Orange dots represent 2005-2007, green 2008-2010, red 2011-2013, and navy-colored dots are for 2014-2016 (as already encountered in Figure 11). The 2008-2010 period (green dots), which included most of the Great Recession, stands apart from the others through very high volatility and mostly negative returns.

**Figure 13. Risks and Returns for Individual 2020 Funds, by Period**



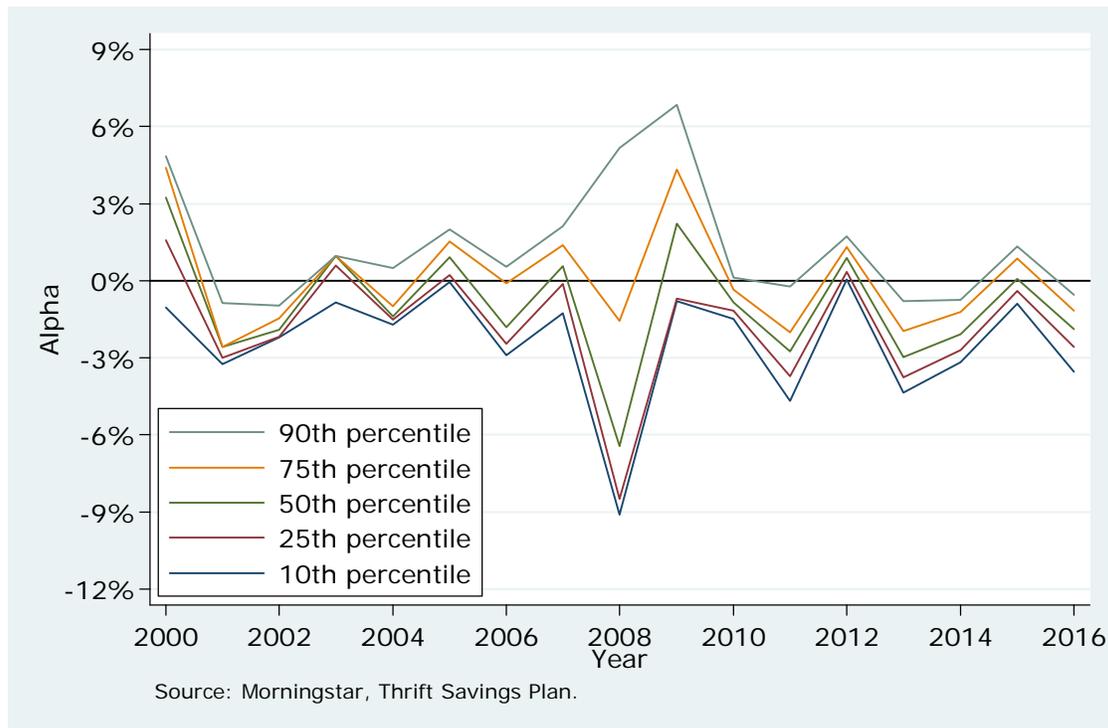
## Risk-Adjusted Performance

The Capital Asset Pricing Model is based on the assumption that the returns of well-diversified portfolios increase with tolerance for risk. Indeed, the previous subsection demonstrated that, outside the Great Recession, rates of return were generally higher for funds that accepted more volatility. In order to compare funds with different tolerances for risk, we calculated their risk-adjusted performance. A commonly used metric is the “alpha,” that is, the intercept of a regression of daily returns of the fund on daily returns of a fund’s benchmark (both net of the return on a risk-free asset). The idea is that a fund may be evaluated by the extent to which it manages to match its benchmark’s performance, controlling for the ups and downs of the benchmark. Specifically for TDFs, another interpretation of alpha is the gap between a fund’s rate of return and the return that may be expected given its risks, i.e., the vertical distance between a fund’s risk-return coordinates (e.g., in Figure 11) and the (conceptual) security market line.

For each individual fund and for every year, we calculated three-factor alphas. Reflecting the underlying asset composition of most TDFs, the three benchmarks used here are indices of the total US equity market, the non-US equity market, and the US bond market.<sup>18</sup> Figure 14 depicts the distribution of three-factor alphas across all TDFs during individual years from 2000 to 2016.

<sup>18</sup> US equity market return as published by Eugene Fama and Kenneth French ([http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\\_library.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html)), non-US equity market as measured by the MSCI ACWI Ex-US Net Total Return index, and US bond market as measured by the Bloomberg Barclays US Aggregate Bond Total Return index.

**Figure 14. Distribution of Risk-Adjusted Performance among All TDFs, by Year**



A TDF that invests in a mixture of diversified US equities, non-US equities, US bonds, and a risk-free asset may be expected to have an alpha equal to the negative of its net expense ratio. Indeed the median alpha is negative in most years. In contrast, the 90<sup>th</sup> percentile is often positive, possibly reflecting actively managed TDFs that outperformed the market. Alpha fluctuated substantially across funds, as demonstrated by the range between, say, the 10<sup>th</sup> and 90<sup>th</sup> percentiles. That range averaged 3.7 percentage points over the 2000-2016 period. Indeed, the risk-return clouds in Figure 11 and other figures suggest that substantial differences in risk-adjusted performance exist across funds.

The median alpha fluctuated over time, ranging from -6.4% to 3.2%. The lowest median alpha and the largest spread (14% between the 10<sup>th</sup> and 90<sup>th</sup> percentile) were reached in 2008, when the market was particularly volatile.

The overall median alpha across all years was -1.18% (not shown in Figure 14), which is roughly consistent with our expectations: the median expense ratio was 0.61% in 2016 (Table 3), and mutual fund expense ratios are known to have diminished in recent years.

We calculated median annual alphas for three groups of funds: those that liquidated sometime during the analysis period, those that merged during the analysis period, and those that remained active at the end of 2016. The median alphas for liquidated funds were lower than for active funds in every year except one during the analysis period, suggesting that poorly performing funds are more likely to liquidate, and that survivor bias is a potential issue in longitudinal analyses that ignore inactive funds. The median alphas for active and merged funds were generally close to one another.

## 5. AN ALTERNATIVE METRIC OF FUND RISK TOLERANCE

As noted above, TDFs can be attractive investment vehicles for retirement savings because they allow the investor (retirement saver) to allocate all assets to a single fund with a diversified underlying portfolio that automatically becomes more conservative as the saver approaches and enters retirement. The conventional wisdom is that savers should select a fund with a target year that is close to the anticipated retirement date. However, as noted above, substantial variation exists among funds with the same target year. For example, the rates of return of some retirement income funds are more volatile than those of some 2020 funds, and some 2020 funds are more volatile than some 2040 funds—see the overlapping clouds in Figure 11 and Figure 12. Put differently, while funds with a remote target year generally invest more aggressively than funds with a near target year, target year alone is not a good measure of risk tolerance.

The fact that investment strategies differ even among funds with the same target year is, at least in part, due to differences in philosophy among fund managers. Some funds aim for preservation of assets upon retirement, whereas others aim to secure retirement resources for many years after retirement. The different strategies are sometimes summarized in investing “to retirement” versus “through retirement.” Both approaches may be suitable. For example, someone who plans to convert his assets into an annuity upon retirement may prefer to plan “to retirement,” whereas someone who intends to gradually draw down assets may be better served with investing “through retirement.” Some fund managers offer multiple TDF families to meet both objectives. For example, John Hancock’s Multimanager Lifetime Portfolio funds “are designed to help manage longevity risk” and its Multi-Index Preservation Portfolio funds follow a more conservative glide path “for an investor who wishes to limit [...] downside risk in the years immediately leading up to retirement.”<sup>19</sup>

While funds may have legitimate reasons to adopt different levels of risk tolerance, the issue may confuse retirement savers. No longer is it sufficient to know one’s anticipated retirement year. Relatedly, plan sponsors may need to research the philosophies of fund families that they consider offering to their plan participants, and communicate a fairly complex message to their participants. This section aims to clarify this discussion with an alternative measure of risk tolerance.

Consider the following metric:

$$\text{Fund Risk Tolerance} = 100 \times \frac{\text{Volatility of the fund}}{\text{Volatility of the US equity market}}$$

where volatility is quantified as the standard deviation of daily rates of return over a three-year period, and the US equity market is represented by the Fama-French index (see footnote 18). We calculated Fund Risk Tolerance for all funds that traded throughout the three-year period from 2014 to 2016.

Figure 15 shows the average Fund Risk Tolerance for retirement income funds and funds with target years from 2000 to 2060. As expected, average Fund Risk

<sup>19</sup> <https://www.johnancock.com/news/investments/2017/02/john-hancock-investments-debuts-new-names-for-target-date-fund-suites--highlighting-open-architecture-and-lower-costs-for-retirement-savers.html>.

Tolerance generally increases with target year, from 28 for retirement income funds to 87-88 for funds with target years 2045 or later. (The pattern is not quite monotonically increasing for 2050 and 2060, probably because of varying composition of fund families.)

**Figure 15. Average Fund Risk Tolerance by Target Year (2014-2016)**

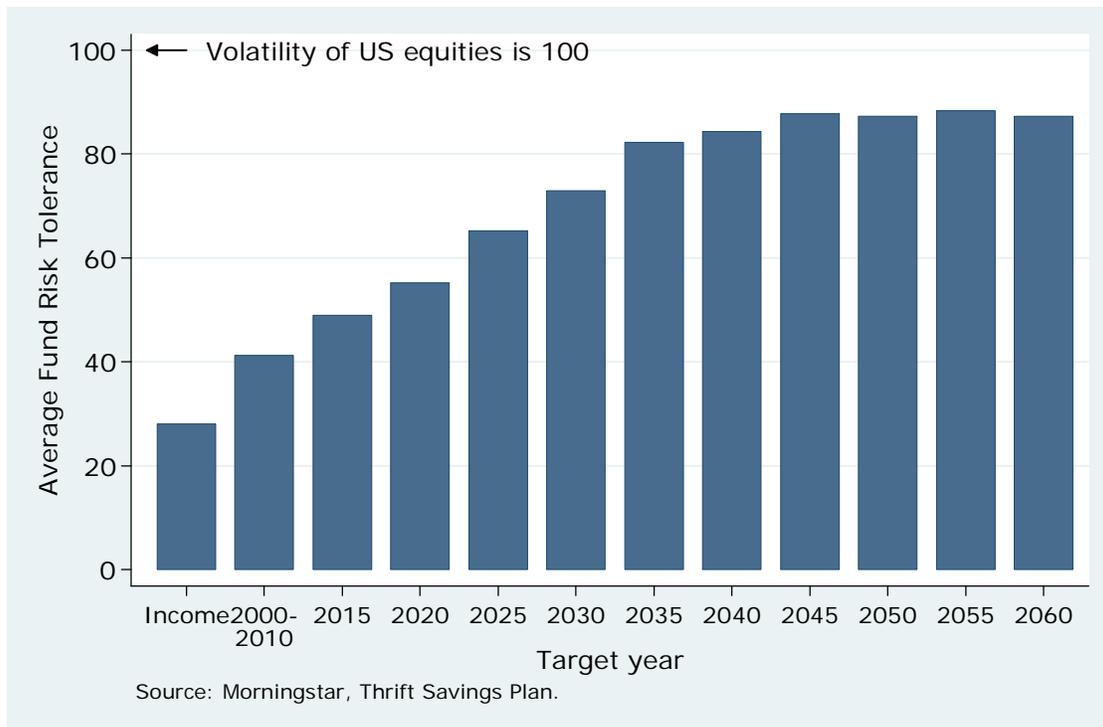


Figure 16 shows average Fund Risk Tolerance over time, restricted to funds with a 2030 target year. As expected, average Fund Risk Tolerance generally decreases over time, because target date funds glide toward more conservative asset allocations over time. The average Fund Risk Tolerance among 2030 funds decreased from 87 in 2006 to 73 in 2016.<sup>20</sup> Its pattern is not quite monotonic, but it appears to be robust to large variations in equity market conditions.

<sup>20</sup> More precisely, since Fund Risk Tolerance is measured as the ratio of three-year volatilities, the 2006 number relates to 2004-2006, the 2007 number to 2005-2007, et cetera.

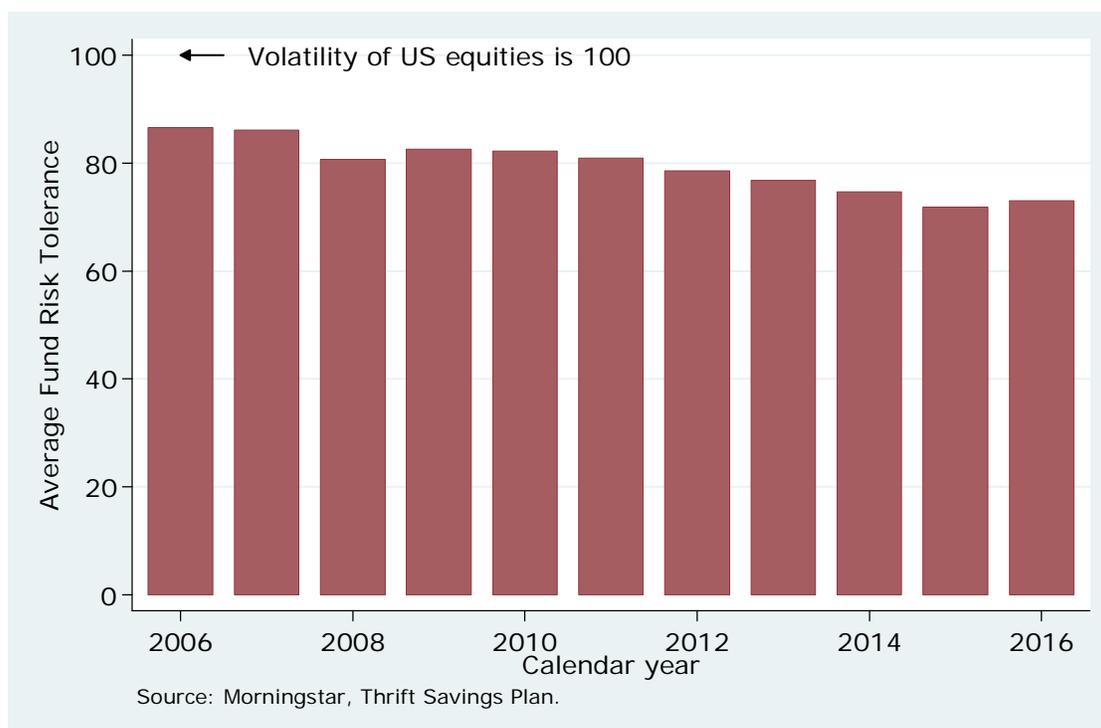
**Figure 16. Average Fund Risk Tolerance of 2030 Funds, by Year**

Table 5 documents Fund Risk Tolerance for illustrative fund families, by target year, based on volatility in 2014-2016. In addition, the last row shows industry-wide average Fund Risk Tolerance, as was also depicted in Figure 15. For example, the Fund Risk Tolerance of Vanguard's Target Retirement family ranges from 29 for its retirement income fund to 87 for its 2050 member.

**Table 5. Fund Risk Tolerance for Illustrative Fund Families and Industry-Wide Average (2014-2016)**

| Fund family                    | Income | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|--------------------------------|--------|------|------|------|------|------|------|------|------|------|
| Vanguard Target Retirement     | 29     | 33   | 46   | 56   | 64   | 71   | 79   | 86   | 87   | 87   |
| Fidelity Freedom K             | 26     | 47   | 54   | 60   | 68   | 82   | 90   | 90   | 90   | 90   |
| T. Rowe Price Retirement       |        | 45   | 54   | 63   | 71   | 78   | 84   | 89   | 90   | 90   |
| TSP Lifecycle                  | 19     |      |      | 46   |      | 62   |      | 72   |      | 82   |
| American Funds Target Date     |        | 43   | 45   | 53   | 63   | 74   | 81   | 82   | 84   | 84   |
| JPMorgan SmartRetirement       | 37     |      | 40   | 54   | 64   | 75   | 82   | 88   | 88   | 88   |
| TIAA-CREF Lifecycle            | 40     | 45   | 50   | 58   | 67   | 75   | 83   | 92   | 92   | 93   |
| Principal LifeTime             | 25     | 40   | 48   | 58   | 65   | 72   | 77   | 83   | 87   | 89   |
| American Century One Choice    | 44     |      |      | 48   | 53   | 59   | 65   | 71   | 77   | 80   |
| John Hancock Multi-Index Presv | 18     |      |      | 30   | 48   | 65   | 74   | 80   | 82   | 82   |
| Industry average               | 28     | 42   | 49   | 55   | 65   | 73   | 82   | 84   | 88   | 87   |

Source: Morningstar, Thrift Savings Plan.

Table 5's columns provide a sense of the Fund Risk Tolerance of any particular fund relative to funds of other families. For example, Vanguard's income fund (29) is roughly in the middle of the risk tolerance range, with the Thrift Savings Plan (19) and the John Hancock Multi-Index Preservation Portfolio income funds (18) at the conservative end of the spectrum and the TIAA-CREF Lifecycle (40) and the

American Century One Choice income funds (44) at the aggressive end. The color-coding is suggestive of the risk tolerance relative to other funds with the same target year, with green denoting conservative and red aggressive.

As noted earlier, some 2020 funds are more risk tolerant than some 2040 funds, but there are no examples of such instances among the (large) funds in Table 5. Instead, for example, the TIAA-CREF Income fund (40) tolerates more risk than the John Hancock 2020 fund (30), and the T. Rowe Price Retirement 2020 fund (63) tolerates more risk than the American Century One Choice 2030 fund (59).

We argue that our Fund Risk Tolerance metric is more informative than target year. Plan sponsors may use it to gauge the overall risk tolerance of fund families and to tailor their educational efforts toward plan participants. Also, retirement savers can use it as one of their criteria to select a fund through a process along the following lines. Suppose someone expects to retire in 2030. The average Fund Risk Tolerance of 2030 funds is 73, and that number can serve as a starting point. If the retirement saver intends to purchase an annuity upon retirement, she may want to opt for a fund with a risk tolerance below 73. If she is more risk-tolerant than her peers, or expects her spouse to retire after she does, a fund with risk tolerance above 73 may be appropriate. Perhaps fund managers or investment advisers can draw up a list of questions to gauge an individual's appropriate category, and recommend funds in that category.

## 6. CONCLUSION

In this study we analyzed the performance of target date funds over time and compared funds among each other. The general patterns were consistent with our expectations: the asset allocation of funds with a remote target date was generally more aggressive than that of funds with a near target date, losses during the Great Recession were more muted for the latter category, and the risk-return profiles of many funds appear to be broadly consistent with portfolio optimization following the Capital Asset Pricing Model. That said, we encountered large differences among TDFs. Funds with the same target year varied widely in their risk tolerance, and risk-adjusted rates of return varied substantially—the difference between the 90<sup>th</sup> and the 10<sup>th</sup> percentile was on the order of 2%-4% per year, and larger than that in some years.

While TDFs are sometimes touted as an elegant solution to the difficult investment allocation decisions faced by retirement savers, it is clear that one size does not fit all. In particular, funds' target years poorly reflect differences in their risk tolerance. We suggest an easy-to-calculate metric of Fund Risk Tolerance that will hopefully help remove some of the confusion around fund selection.

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