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A lifecycle analysis of the performance of TIAA's Traditional Annuity in a Target Date Fund

Abstract

Using data from 1973–2021, we examine the impact of replacing a portion of the fixed-income mutual fund allocation in a Target-Date Fund (TDF) with either TIAA Traditional Retirement Annuity (RA) or Supplemental Retirement Annuity (SRA). Analyzing 27 different scenarios, we find that TDFs with TIAA Traditional tend to outperform TDFs without Traditional during the accumulation phase. We then annuitize the entire Traditional balance in the TDF at retirement and a sum necessary to match that income from the TDF without Traditional. The latter must annuitize an additional 16% of assets (on average) to match Traditional RA/SRA initial payouts and payout growth during retirement. TDFs with RA have end-of-payout phase asset balances that are, on average, over $85K (5.3%) greater than TDFs without Traditional. Results using TIAA Traditional RA compared to TIAA Traditional SRA are similar, but the RA provides slightly superior performance due to its illiquidity premium.

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DISCLOSURE

TIAA Traditional is issued by Teachers Insurance and Annuity Association of America (TIAA), New York, NY.

This Institute grant sponsored academic paper was written by third-part economists at Charles Rivers Associates and the University of Denver. It uses historical data and conducts financial performance analyses for research purposes only. It is not representative of an actual product offering nor does it provide investment analysis of a product that is offered.

The analysis compares the investment performance and retirement income generating capacity two hypothetical target-date fund strategies. The approach is for research purposes only and not meant to convey performance from any existing product. Per the Investment Company Act of 1940, an annuity cannot be part of a mutual fund. However, an annuity can be included in a collective investment trust (CIT) or a managed account within a target-date framework.

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Relying on National Center for Education Statistics (NCES) faculty salary data, we find that annuitization of the entire Traditional balance at retirement provides an average income replacement percentage (IRP) in the Conservative risk profile of about 30% over five different 30-year accumulation periods. When combined with expected income from Social Security, IRPs thus range from about 60–75%. Across the scenarios we examine, annuitization of the entire Traditional RA balance at retirement leaves approximately three quarters of the accumulated assets remaining in the TDF. These assets can be used in retirement for lump-sum withdrawals, additional annuitization, or a bequest motive. The TDF with Traditional thus addresses both longevity risk and "annuity puzzle" concerns. Including Traditional within a TDF with the nudge to annuitize the entire Traditional balance at retirement extends the qualified default structure made popular by the Pension Protection Act of 2006 by embedding both asset allocation and retirement income defaults in one instrument.

1. Introduction

Retirement planning involves more than just a strategy to accumulate assets. In the classic life cycle theory model of Ando and Modigliani (1963), retirement consists of two phases—accumulation and distribution. The latter phase—usually in retirement—necessarily brings about consideration for the provision of income over an uncertain life expectancy. This challenge reflects the "economic value of annuitization," as quantified in the pioneering research of Yaari (1965), who noted that in planning for the future, an individual consumer "must take account of the fact that he does not know how long he will live" (p. 137).

As private defined benefit (DB) plans have declined in number and defined contribution (DC) plans have become a mainstay for retirement, individuals and households have faced the challenges associated with both the accumulation of wealth and the provision of lifetime income during the retirement phase. The Pension Protection Act (PPA) of 2006 introduced a policy that assists individuals and households with accumulation phase challenges by allowing the Target Date Fund (TDF)[1] to be a Qualified Default Investment Alternative (QDIA) in DC plans. Combined with auto-enrollment, the TDF offered DC plan participants unable or unwilling to choose alternatives a default approach for asset accumulation. The TDF automatically adjusts asset allocation ("the glideslope or glidepath") to become more conservative (decreasing the allocation to equity oriented mutual funds and increasing the allocation of fixed-income mutual funds) as the stated retirement date of the TDF approaches. Over the past 15 years, TDFs have become very popular in DC retirement plans. For example, based on a small sample of large university and university-system plans, roughly 70% of participants have assets in a TDF.

While the glidepath (or glidescope) in TDFs addresses the asset accumulation challenge in DC plans for many, the lifetime income provision challenge remains. Unlike mutual funds, which are designed for wealth accumulation, annuities are an investment vehicle designed for both accumulation of assets and distribution of lifetime income (Spatt, 2017). Annuities would seem to be a natural fit for a DC plan, but the inclusion of annuity options in DC plans is quite rare in the for-profit firm 401(k) plan context. The history of the 401(k) was as a supplementary retirement plan funded by the profits of the firm, and not a primary tool for providing retirement income. In contrast, annuities are more common in the nonprofit 403(b) context, especially in university plans. History again explains the trend, as 403(b) plans in higher education were originally intended to be a source for income and were required to be funded with annuities.

Over the past decade, a series of policy initiatives have reflected concerns about challenges in the provision of lifetime income in DC plans. For example, a U.S. Government Accountability Office (GAO) report in 2016 made several recommendations that promoted annuity use in DC plans, including annuity selection considerations, limited liability for sponsors, and required minimum distribution relief. In late 2019, the SECURE Act codified some of these GAO recommendations and added others, requiring income projections to be included in DC plans as well as providing safe harbor protections for sponsors' choice to include in-plan annuities (Kreps et al., 2020). While annuities remain rare in 401(k) plans, the trend for inclusion is upward. From 2019 to 2021, the percentage of 401(k) plans offering annuities has increased from 9% to 17% (Correia, 2021; O'Brien, 2019).

While annuity options are growing in DC plans, research has documented that individuals are reluctant to annuitize wealth despite the advantages of doing so (e.g., Benartzi et al., 2011; Brown et al., 2013). The "annuity puzzle" research offers a range of explanations as to why this phenomenon

1 Comparison of target-date fund portfolio in this paper are for research purposes only and not meant to convey performance from an existing fund. Per the Investment Company Act of 1940, an annuity cannot be in a mutual fund. However, an annuity can be in a collective investment trust (CIT) or other custom QDIA portfolios.

exists. These include an investment mindset, concerns for annuity costs, fear for the loss of control of funds, the inability to respond to the need for a lump-sum withdrawal, and the desire to satisfy a bequest motive. Addressing "annuity puzzle" concerns can help to reduce the gap between Yaari's "economic value of annuitization" and consumers' perceived value.

This research steps into the intersection of retirement theory, the value of default options ("nudges") in TDF plans, and the annuity puzzle by analyzing the lifecycle impact of including TIAA Traditional Annuity as an investment in a TDF. Using 49 years of data (1973–2021), we analyze the lifecycle impact of replacing part of the fixed-income allocation in a TDF with TIAA Traditional. TIAA Traditional is a fixed annuity backed by the General Account of TIAA. Due to the management of interest rate risk by TIAA in its General Account, TIAA Traditional has never had a monthly negative return in its history, as required by law and documented in the annuity contract. We analyze both the Retirement Annuity (RA) contract and the Supplemental Retirement Annuity (SRA) contract of TIAA Traditional.[2]

TIAA Traditional contains the feature of vintages, which apply returns on contributions that reflect interest rates prevailing at the time.[3] As the assets in TIAA's General Account are ultimately returned to participants net of operating expenses, reinvestments, and set aside to capital, payout rates on the various vintages in TIAA Traditional tend to increase over time as excess profits are released. There are three ways TIAA uses capital in a return of value to the participant: additional interest above guarantees; additional initial income based on vintage calculation, increases to the additional amounts portion of the income payment post annuitization. Over the past 25 years ending with 2022, TIAA has increased payments 15 times averaging over 1%.[4] This makes the TIAA Traditional annuity a retirement product that truly spans the life cycle of individuals, as it connects savings behavior directly to lifetime income. In contrast, most 401(k) plans have only mutual funds as investment options. Mutual funds leave the plan participant with a sum of money whose potential conversion into a payout stream requires selling assets periodically exposing them to interest rate risk and/or purchasing an immediate annuity. Highly volatile security prices and interest rates make either activity challenging, especially in the context of an uncertain life span and declining decision-making ability in old age (Agarwal et al., 2009).

We begin our analysis by using TDF "glidepaths" provided by TIAA that reflect conservative, moderate, and aggressive risk profiles. The conservative profile allocates the least amount to equity across the glidepath, while the aggressive profile allocates the most. Each profile follows the typical glidepath that reduces equality allocations closer to retirement. As the TDF becomes more aggressive, the proportion of the fixed income allocation relative to the equity allocation becomes smaller, *ceteris paribus.* We then replace a portion of the fixed income allocation in the TDFs with TIAA Traditional and compare the results to TDFs without TIAA Traditional, which have the standard mutual fund components across asset classes. We recognize the liquidity constraints on investments in some versions of TIAA Traditional. We thus require that when the fixed income sleeve is rebalanced during the accumulation phase, Traditional is never sold, but only bought, preserving the potential for future loyalty bonus amounts when annuitized.

We first compare the ending accumulation balances of the TDFs with and without Traditional. For each of the three TDF risk profiles, we examine nine different accumulation and distribution (payout) scenarios. We assume a participant stays in the same risk profile (i.e. moderate). Accumulation starts from 1973 to 1980, and retirement dates start between 1995 and 2010. TDFs with the TIAA Traditional Retirement Annuity (RA) contract have significantly greater end-of-accumulation values compared to the TDF without Traditional in 93% (25 out of 27) of the scenarios we examine. The TDF with TIAA Traditional Supplemental Retirement Annuity (SRA) contract accumulation results are also positive relative to the TDFs without Traditional, with end-of-accumulation values greater in 17 of the 27 scenarios. The SRA version of TIAA Traditional has full liquidity for withdrawals at any time. The accumulation phase results are aligned with the findings in Babbel et al. (2015, 2022), who show that replacing a portion of a fixed-income allocation with TIAA Traditional in a portfolio provides superior mean-variance asset accumulation results.

2 The RA is typically used in a primary DC plan, and the SRA in a supplemental plan. The contracts vary in some dimensions, such as liquidity provisions, where the RA does not permit lump-sum withdrawals.

3 For more details, see Goodman and Richardson (2014) and Goodman and Richardson (forthcoming).

4 TIAA may share profits with TIAA Traditional Annuity owners through declared additional amounts of interest during accumulation, higher initial annuity income, and through further increases in annuity income benefits during retirement. These additional amounts are not guaranteed beyond the period for which they were declared.

The accumulation results alone, however, do not capture the entire life cycle impact as they do not illustrate the impact of increasing payouts during retirement that Traditional provides. Thus, we next consider the payout phase impacts of including TIAA Traditional in a TDF to examine the benefits for those participants who have made contributions over their working lives. As the default condition, we assume immediate annuitization of the entire accumulated TIAA Traditional balance at retirement (age 65) with a single-life annuity (10-year guarantee). For the TDFs without Traditional, we assume the purchase of an immediate annuity (at the retirement date market rate) of a balance necessary to match the income from the TDF with Traditional. We also assume additional annuitization from the TDF without Traditional asset balance to match the growing TIAA Traditional annuity payouts. Across the 27 scenarios, on average, the TDFs without Traditional must annuitize 16% more of their accumulated balance to match payouts from TIAA RA/SRA Traditional. The average internal rates of return achieved by annuitizing Traditional are about 1.6 percentage points higher, on average, than the returns earned by annuitizing at current market rates.

We then compare end-of-distribution phase balances (on December 31, 2021) for the TDF with and without Traditional. In the latter, these are the residual balances after accounting for the additional annuitizations necessary to match the increasing income provided by Traditional during the payout phase. TDFs that had accumulated with a portion of assets ascribed to Traditional RA/SRA have significantly greater residual balances than those without Traditional, averaging more than a $85K/$70K difference (5.3%/4.3%) over the 27 scenarios we examine, using an initial monthly contribution or $300 increasing 4% per annum. Ending period balances of the TDF with Traditional RA (SRA) are higher in 26 (23) of the 27 scenarios.

TDFs with Traditional thus tend to exhibit not only superior ending accumulation period performance but also extend that superior performance to the end of the payout phase. Longer payout periods amplify this advantage and highlight the longevity risk protection embedded in the TDFs with Traditional. This trend is illustrated by the results of the scenario with the shortest distribution period (12 years: 2010–2021), which is the only case where the TDF (aggressive risk profile) with Traditional RA contract has a lower end-of-payout balance than the TDF without Traditional. Given life expectancies of about 20 years, contingent upon reaching a normal retirement age of 65, the results illustrate that the TDF with Traditional offers valuable longevity protection for most retirees.[5] The results also clearly show that merely comparing account balances between the TDFs with and without Traditional at the end of the accumulation phase is not appropriate when the payout phase is considered.

Lastly, we examine income replacement percentages (IRPs) provided from the annuitization in the TDF with Traditional.[6] We provide a realistic plan participant context by relying on National Center for Education Statistics (NCES) average faculty salaries for four-year public universities as the basis for analysis. To calculate IRPs, we standardize accumulation periods at 30 years and examine five different starting dates from 1973 through 1987. We assume complete annuitization of the Traditional balance at retirement (age 65), as above, and a baseline contribution (salary deferral plus match) of 15% of salary. We find an average IRP across the five scenarios in the Conservative allocation of approximately 30%. Reflecting the higher vintage interest rates in the earlier start dates, IRPs decrease monotonically as accumulation start dates move closer to the present. When the TIAA Traditional income stream is combined with the expected Social Security income in the first year of retirement (Center on Budget and Policy Priorities, 2023), the average IRP in the conservative allocation ranges from 60 to 75% for high- to low-income workers. These IRPs for lower income workers are within or close to a range that literature has shown to be sufficient to sustain the existing standard of living in retirement (Aon Consulting, 2008).

Consistent with literature showing the benefit of choice architecture that embeds default structures to aid decision making (e.g., Kahneman & Tversky, 2000; Thaler & Sunstein, 2008), the TDF with TIAA Traditional is a retirement vehicle that embeds two nudges. First, the default asset allocation glidepath in the accumulation phase remains in place, so a participant need not make investment decisions, as allocations automatically become more conservative as a person approaches retirement. Second, the inclusion of Traditional as a replacement for part of the fixed-income mutual fund allocation represents an income-oriented nudge. A participant need not act to purchase Traditional during accumulation as positive rebalancing into the

5 See the Social Security Administration's Actuarial Life Table at https://www.ssa.gov/oact/STATS/table4c6.html.

6 We define IRP as the annual income provided by the Traditional annuity at retirement divided by the ending annual salary from the NCES (multiplied by 100). We also compute IRP by adding the expected annual Social Security payment in the first year of retirement to the Traditional annual payment and dividing by the ending annual salary. See Aon Consulting, 2008.

fixed-income allocation is done automatically. At retirement, the participant immediately annuitizes the entire Traditional balance. This TDF structure aligns more closely with life cycle retirement theory (e.g., Ando & Modigliani, 1963) by addressing both the accumulation and distribution phases.

Using actual faculty data shows that this double-nudge structure can provide IRPs (when combined with Social Security) that approximate those necessary to maintain a standard of living in retirement. At the same time, the double-nudge structure leaves significantly greater assets in the TDF to address future lifetime needs or shocks (e.g., health-related expenses) or to satisfy legacy (i.e. bequest) motives. The superior life cycle results of the TDF with Traditional hold regardless of whether the participant uses the Conservative, Moderate, or Aggressive allocation.

The paper proceeds as follows: In Section II, we describe the sources for our return and glideslope data. We also provide illustrations of the algorithm used to rebalance Traditional into the fixed-income allocation. In Section III, we compare the ending accumulation phase balances, default annuitization balances and income levels, and end of payout phase balances for the TDFs with and without Traditional. In Section IV we examine IRPs. Section V offers a brief discussion of the results and concludes.[7]

2. Data and Target Date Fund glidepaths

We begin by relying on the TDF glidepaths we received from TIAA to adjust the asset allocations over the life of the fund, becoming more conservative as retirement and the years beyond approach. The TDFs include the following asset classes:

- Large-Cap Blend
- Small-Cap Blend
- Real Estate
- International Equity
- Bonds
- Treasury Inflation-Protected Securities (TIPS)
- Cash
- TIAA Traditional

Replacing a portion of the fixed income amount with TIAA Traditional requires a separate glidepath between Traditional and bond mutual funds. We analyze nine different accumulation and distribution scenarios over a 49-year period from 1973–2021. Data for the Real Estate sector is not available for the entire period, so we merge that sector into the equity classes that have data. The modified asset classes we consider are:

- Large-Cap Blend, with glidepath share being the sum of U.S. large stocks and 50% of the Real Estate share
- Small-Cap Blend with glidepath share being the sum of U.S. small stocks and 50% of the Real Estate share
- International equity, represented by the MSCI World ex USA index
- Bonds, with glidepath share being the sum of the Bond and TIPS shares
- Cash, represented by Bank of America/Merrill Lynch US 3-Month Treasury Bill Index
- TIAA Traditional crediting rates

We note that the return series for the original "Bond" asset class (not including TIPS) is a weighted average of monthly returns for U.S. long-term corporate (25%) and government (25%) bonds, and intermediate-term government/credit index returns (50%), to include both long-term and intermediate-term U.S. bonds. We obtain monthly returns that are net of the appropriate average fund fees and expenses from the Investment Company Institute (ICI). Historical TIAA Traditional crediting rates are obtained from TIAA.

As indicated above, an important goal of our study is to compare the performance of the TIAA Traditional retirement annuities during the payout phase, in terms of their payout streams vis-à-vis the amounts needed to obtain the same streams of monthly payouts using immediate annuities in the marketplace. Payout data for the TIAA Traditional annuities was provided by TIAA. Payout data for market immediate annuities was obtained from Annuity Shopper, which has been a source of annuity data in previous academic studies (e.g., Wettstein et al., 2021).

7 A detailed Appendix is available to the reader upon request.

3. Performance of the TIAA Traditional annuity during the accumulation and payout phases

Table 1 shows the life cycle scenarios we examine. The nine scenarios considered for each TDF risk profile—Conservative, Moderate, and Aggressive—span the 1973–2021 period (49 years of monthly return data).[8] The period 1973–2021 includes several episodes of significant bull and bear markets, including the significant stock market declines of the mid-1970s, the tech bull market of the mid-to-late 1990s, the bursting of the "dot-com bubble" in the early 2000s, and the 2008 financial crisis. During our period of study, interest rates have fallen dramatically due to varying macroeconomic conditions and associated Federal Reserve and government policies. The differing starting dates, accumulation periods, and payout phase lengths highlight how the distribution of historical returns for the different asset classes results in different patterns of ending balances for both the accumulation and payout phases, as well as differing annuitization amounts and total payouts over the respective payout phase length.

Each scenario considers three hypothetical TDF funds, one including the TIAA Traditional RA, one including TIAA Traditional SRA, and one without TIAA Traditional. The TDFs with Traditional includes both bonds and the TIAA Traditional annuity with the weights assigned by the glidepath. The TDF without Traditional has the standard fixed income mutual funds that comprise the bond allocation. In each case, we assume an initial monthly contribution of $300, which afterward grows at the annual rate of 4%.

TABLE 1. SCENARIOS FOR ACCUMULATION AND PAYOUT PHASES

Scenario	Start of Accumulation Phase	Start of Payout Phase	Years in Accumulation Phase	Years in Payout Phase
1	1/1/1973	1/1/2003	30	19
2	1/1/1973	1/1/1998	25	24
3	1/1/1973	1/1/1995	22	27
4	1/1/1975	1/1/2005	30	17
5	1/1/1975	1/1/2000	25	22
6	1/1/1975	1/1/1997	22	25
7	1/1/1980	1/1/2010	30	12
8	1/1/1980	1/1/2005	25	17
9	1/1/1980	1/1/2002	22	20

Note: In all cases, the end of the payout phase is December 31, 2021. This constrains the length of the payout phase to as little as 12 years in Scenario 7.

The TDFs are rebalanced at the start of each calendar year to bring the equity and bond shares in line with their prescribed glidepath allocation.[9] In the case of the TDF without Traditional, the rebalancing strategy allows for full adjustment of the individual accounts' actual portfolio shares in the TDF to their respective prescribed glidepath shares at the time of rebalancing. In the case of the TDF with Traditional, the bond account is used as a buffer to avoid selling any amount of the Traditional balance. The combined TIAA Traditional plus bond accounts share will thus be equal to the prescribed fixed income glidepath share at the time of rebalancing. The rebalancing is implemented in this case as follows:

- Negative rebalancing out of the Bond+TIAA Traditional: All the outflow comes from the bond account.
- Positive rebalancing into the Bond+TIAA: The amount of the inflow that goes into the TIAA account is calculated to bring the share of the TIAA Traditional balance as close as possible to its prescribed glidepath share at the time of rebalancing. The remainder of the positive rebalancing amount goes into the bond sleeve.

8 Payout data received from TIAA include up to 30 years of investment vintages and do not extend beyond December of 2021.

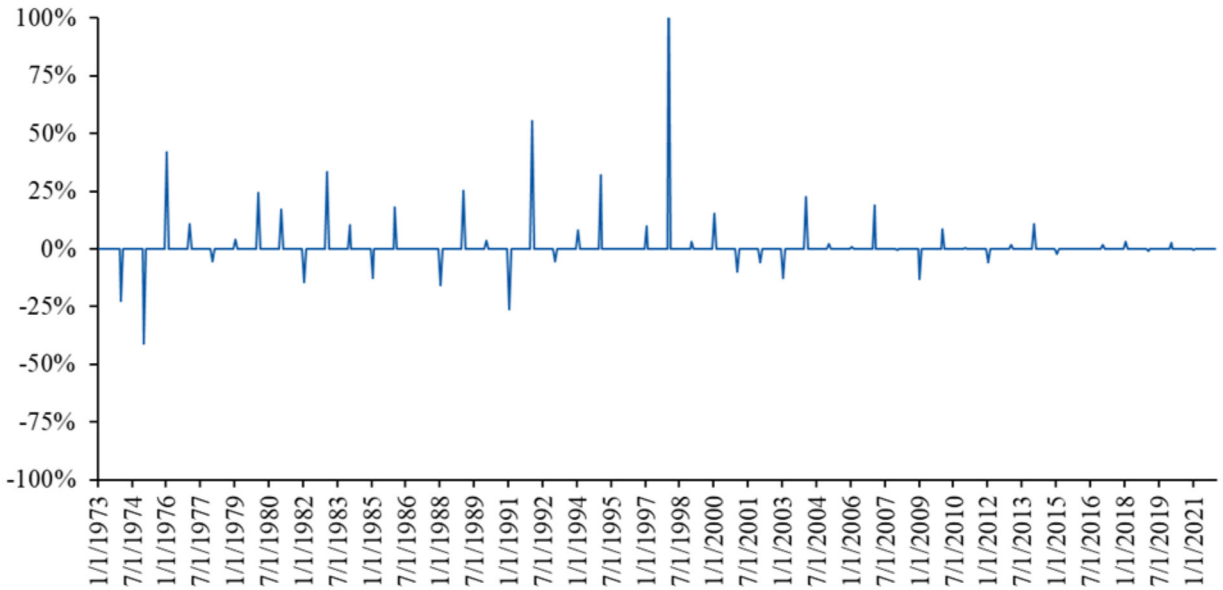
9 Our model allows for more frequent rebalancing, such as quarterly or semiannually.

This rebalancing strategy is based on information available to the fund manager at the end of the month prior to rebalancing, both because the prescribed glidepath shares for each year are known and because the amounts of rebalancing needed for the equity and fixed income glidepaths (as well as the bond and TIAA Traditional glidepaths within the fixed income sleeve) are also known. For the Conservative risk profile, TIAA Traditional comprises approximately 18% (66%) of the total asset (fixed income sleeve) balance at inception and 30% (60%) of the total asset (fixed income sleeve) at retirement. For the Moderate and Aggressive risk profiles, the percentages of TIAA Traditional at inception are 9% and 3% of assets, respectively. At retirement, the TIAA Traditional balances are 27% and 23% of assets in the Moderate and Aggressive allocations. For the Moderate and Aggressive risk profiles, the percentages of TIAA relative to the fixed income sleeve remain within a few percentage points of those in the Conservative risk profile.

The rebalancing strategy we use does not guarantee that the share of the TIAA Traditional account balance *at the end of the accumulation phase* equals or closely approximates the corresponding prescribed TIAA Traditional glidepath share because there may be no rebalancing into the TIAA account for one or more years before the end of the accumulation phase. Nevertheless, it guarantees that no funds are withdrawn from the TIAA Traditional account during the entire accumulation phase in order to preserve the greatest potential for income replacement at retirement.

As a representative example of the rebalancing in the TDFs with TIAA Traditional, consider Figure 1 below, whose accumulation period begins in 1973 and ends in 1998.

FIGURE 1. NET REBALANCING AMOUNTS IN AND OUT OF THE BOND ACCOUNT IN THE TDF WITH TIAA RA (AS A PERCENT OF BOND ACCOUNT BALANCE)



This scenario illustrates how the rebalancing in the bond sleeve reacts to changes in equity and fixed income values over the accumulation period being examined. In the mid-1970s, for example, there are prominent sales in the fixed income sleeve to accommodate the purchases of equity securities necessary to maintain the equity-heavy glideslope following a period where equity securities had fallen dramatically in value. In contrast, during the mid-to-late 1990s, there are large purchases in the fixed income sleeve to rebalance the glidepath after equity values had dramatically increased. Over the entire accumulation period, the largest proportional sale in the fixed income sleeve is below 50% and the bond buffer is sufficient to avoid any sales of TIAA Traditional.

To illustrate the life-cycle effects of the Traditional RA or SRA, Table 2 shows the TDF asset accumulation results for Scenario 2 (1973–1998), the payout from annuitizing the entire TIAA Traditional balance at retirement, the total amount of the annuitization necessary to match the payouts of the TDF with Traditional, and end-of-payout

period balances. The results show the dominance of the TDF with Traditional during both the accumulation and payout periods. In the case of the latter, the TDF without Traditional must continue to annuitize funds during the payout phase to match the growing payouts Traditional offers through its share of profits approach that continues through the annuitization phase. The result is a higher end-of-payout balance for the TDF with Traditional.

Table 2 and Figure 2 results are highly representative across the 27 scenarios we examine as the TDF with Traditional has both a larger end-of-accumulation period balance and a larger end-of-payout period balance. Due to TIAA's sharing the profits approach. TIAA shares profits in accumulation by crediting higher than the minimum interest rate and at retirement by rewarding long term contributors with a higher initial payout rate (i.e., loyalty bonus). In addition, TIAA may increase payment amounts and has done so 15 times in the last 25 years, averaging over 1%. In particular, the results highlight the benefits of being a career contributor to TIAA Traditional (the "loyalty bonus"). For a "career" contributor to Traditional, TIAA has increased payouts by an average of over 1% per year during the period from 1995 to 2020 (TIAA, 2022). This scenario has a 24-year payout period, which amplifies the power of the loyalty bonus, shown by the comparison of the internal rates of return (IRR) between the annuitization with the TDF with Traditional and the immediate annuitization of accumulation proceeds with the TDF without Traditional. The IRR is calculated as the rate of return necessary to make the net present value of annuity investments and payouts equal to zero at the time of retirement. In general, an IRR will rise as the longevity of payouts increases, consistent with the longevity protection offered by purchasing an annuity. In the scenario analyzed in Table 2, the annuitization IRR for the TDF with Traditional is 8.28% versus 6.44% for the TDF without it.[10] The IRR for the TDF with Traditional is the result of the TDF without Traditional needing more assets to match the retirement income amount of the TDF with Traditional.

In general, the scenario analysis shows that the end-of-payout phase balance is much larger in the TDF with Traditional than the TDF without Traditional, often over $100,000, *even if the TDF with Traditional had a very similar or even smaller balance at the end of the accumulation phase.* This is due to the impact of the loyalty bonus, which requires the non-TIAA TDF to expend funds during the payout phase to purchase annuities that provide income necessary to match the growing RA/SRA payouts.

The cumulative amount of annuitized income in the TDF without Traditional is typically over 20% in the longer payout scenarios we examine. Figure 2 shows that the TDFs without Traditional must continue to annuitize funds during the payout phase to match the growing income streams TIAA Traditional offers. As the payout phase gets longer in duration, the advantage offered by TIAA Traditional becomes more pronounced.

TABLE 2. A REPRESENTATIVE SCENARIO ANALYSIS

TDF Risk Profile:	Conservative
Scenario	2
Start of Accumulation Phase:	1/1/1973
Start of Payout Phase:	1/1/1998
Years in Accumulation Phase:	25
Years in Payout Phase:	24
End of Payout Phase:	12/31/2021
Total Contributions:	$152,654
Total Annuity Payout:	$402,730
TDF:	TDF with Traditional RA
Annuity IRR (Traditional)	**8.28%**
Annuity IRR (no Traditional)	**6.61%**

10 A detailed illustration for all scenarios considered is presented in an Appendix available from the TIAA Institute.

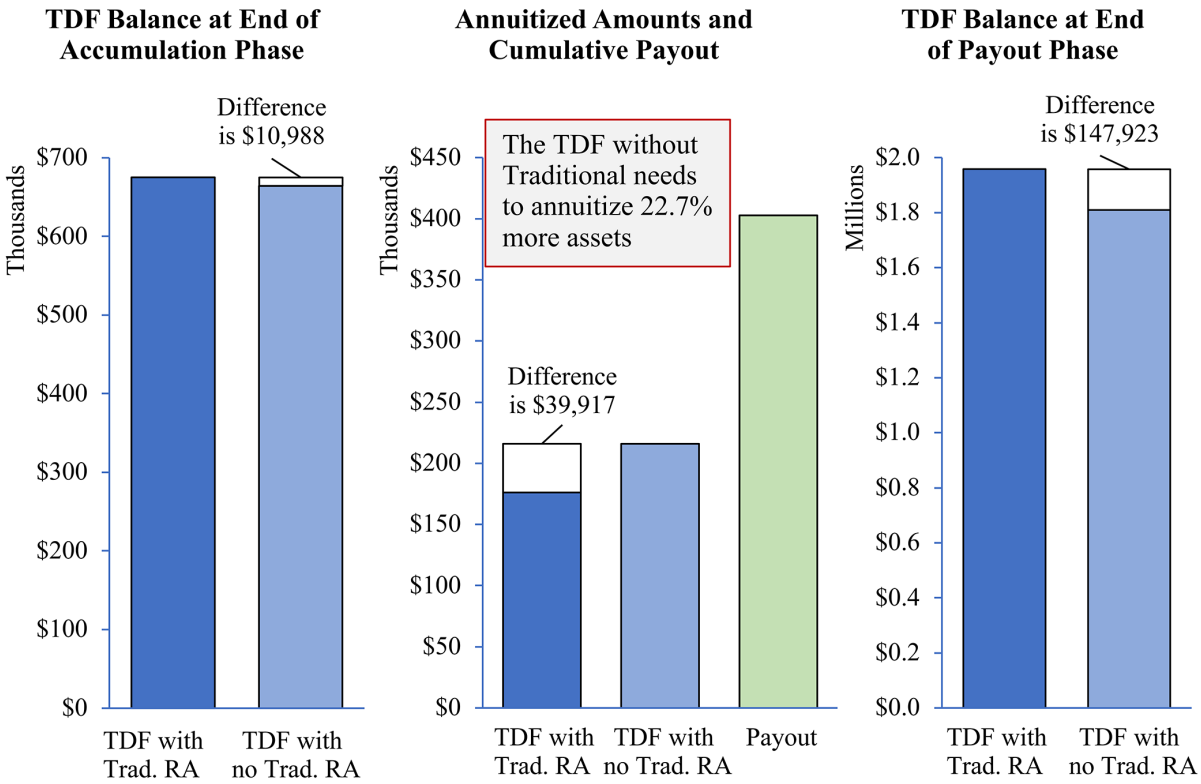


FIGURE 2. REPRESENTATIVE SCENARIO: CUMULATIVE ANNUITIZED BOND BALANCE VERSUS ANNUITIZED TIAA BALANCE (SCENARIO 2 WITH CONSERVATIVE PROFILE)

Tab A: TDF with RA

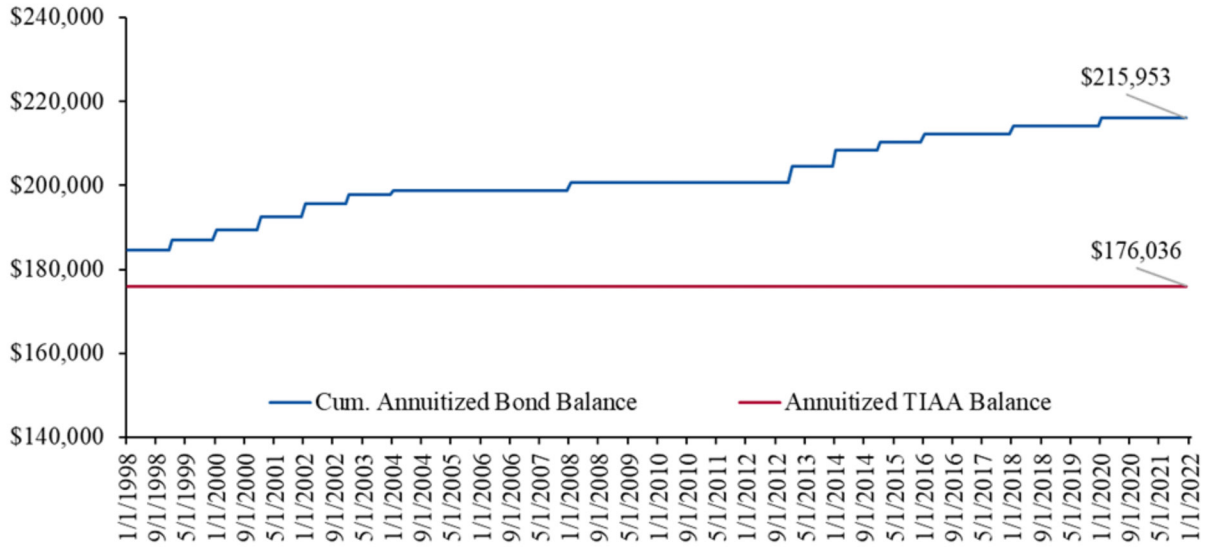


FIGURE 2. REPRESENTATIVE SCENARIO: CUMULATIVE ANNUITIZED BOND BALANCE VERSUS ANNUITIZED TIAA BALANCE (SCENARIO 2 WITH CONSERVATIVE PROFILE) CONTINUED

Tab B: TDF with SRA

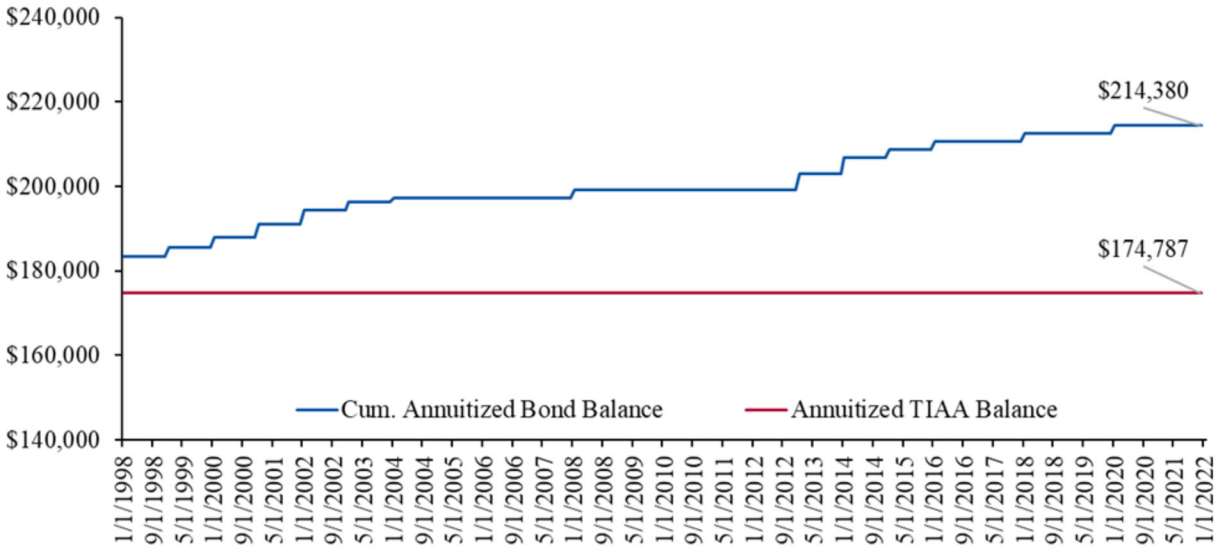


Table 3 and Figure 3 illustrate an outlier scenario. In Scenario 7, the payout phase starts on 1/1/2010 and ends on 12/31/2021. This is the shortest payout period analyzed—12 years. For the TDF (conservative risk profile) with RA, the end-of-payout period difference is still positive (by about $20K), but this positive difference is much smaller than in the other scenarios. The combination of relatively high immediate annuity payouts in 2010 and the short duration of the payout phase explains this outlier result. In Scenario 7, the total contributions of $205,581 are higher than total annuity payouts of $187,776. Given the proximity of the end-of-payout balances between the TDFs with and without Traditional, this 12-year distribution scenario could thus be considered a "breakeven" payout period between the TDF with and without Traditional.

TABLE 3. AN OUTLIER SCENARIO ANALYSIS

TDF Risk Profile:	Conservative
Scenario	7
Start of Accumulation Phase:	1/1/1980
Start of Payout Phase:	1/1/2010
Years in Accumulation Phase:	30
Years in Payout Phase:	12
End of Payout Phase:	12/31/2021
Total Contributions:	$205,581
Total Annuity Payout:	$187,776
TDF:	TDF with Traditional RA
Annuity IRR (Traditional)	**-2.94%**
Annuity IRR (no Traditional)	**-3.52%**

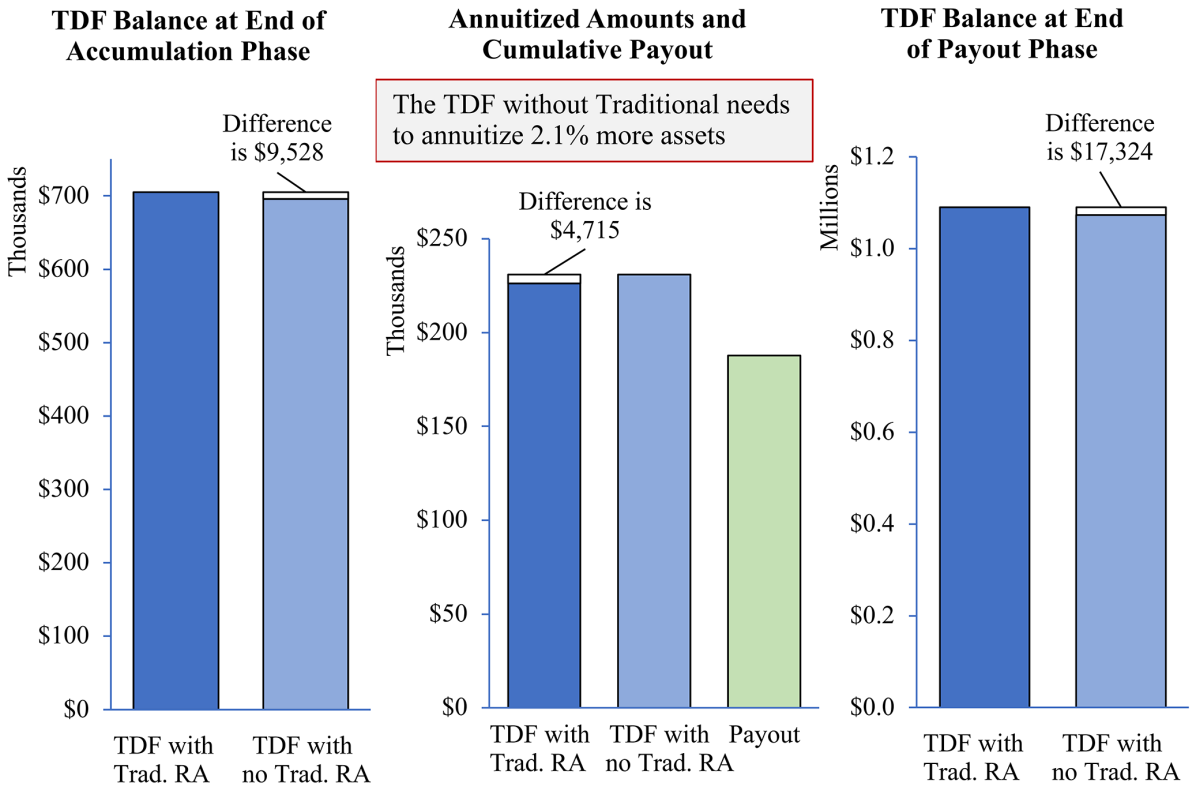


FIGURE 3. OUTLIER SCENARIO: CUMULATIVE ANNUITIZED BOND BALANCE VERSUS ANNUITIZED TIAA BALANCE (SCENARIO 7 WITH CONSERVATIVE PROFILE)

Tab A: TDF with RA

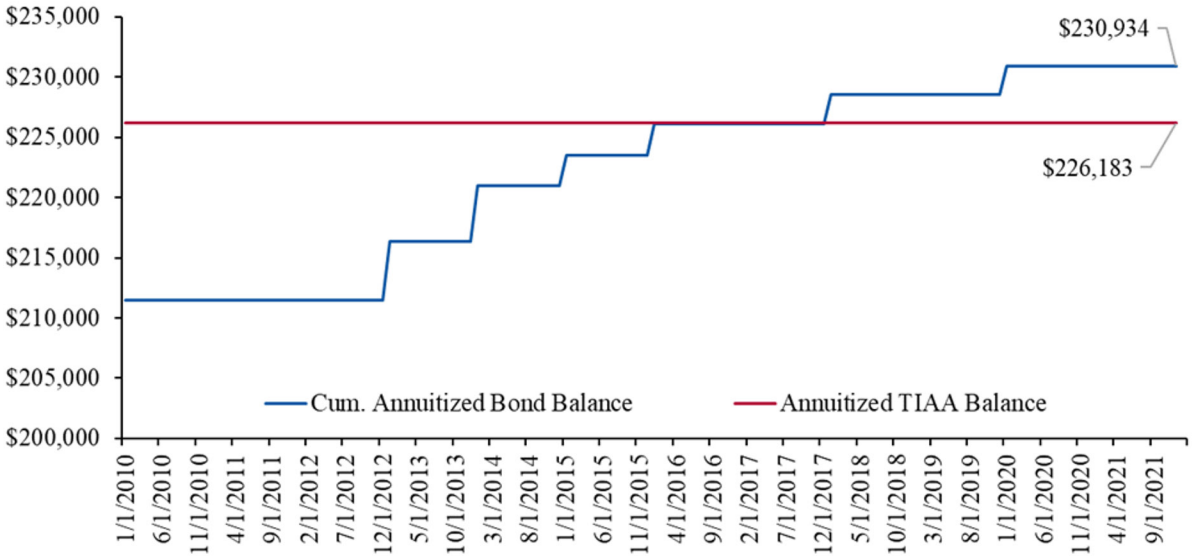
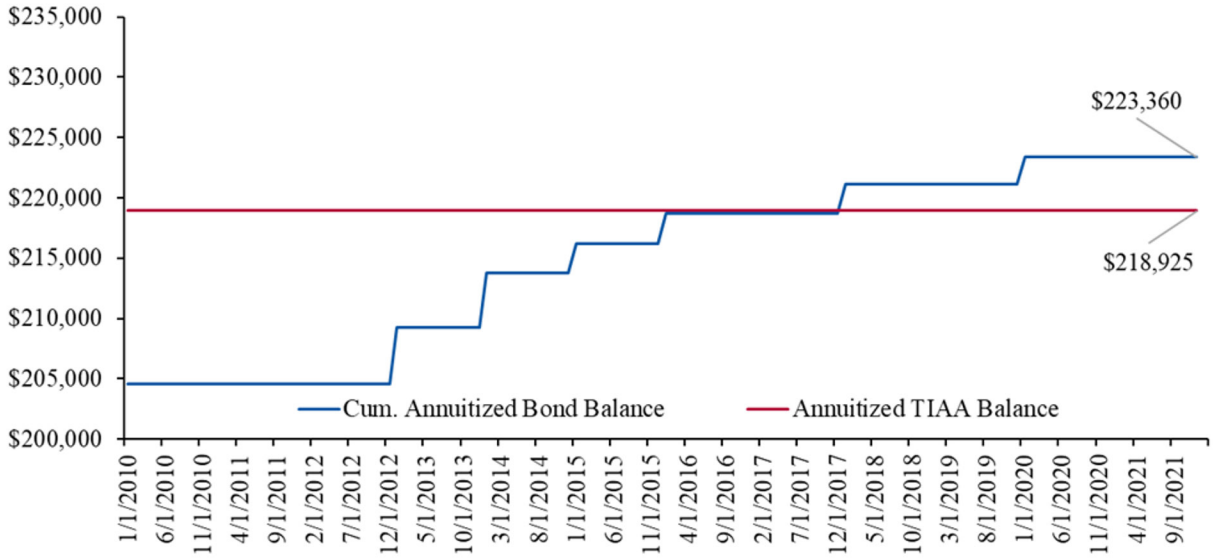


FIGURE 3. OUTLIER SCENARIO: CUMULATIVE ANNUITIZED BOND BALANCE VERSUS ANNUITIZED TIAA BALANCE (SCENARIO 7 WITH CONSERVATIVE PROFILE) CONTINUED

Tab B: TDF with SRA



To illustrate the impact of a longer payout period, Table 4 and Figure 4 below show another scenario where immediate annuity payouts are relatively high compared to the Traditional annuitization rate at the retirement date. This is an analysis of Scenario 5, where retirement begins in January 2000. However, in contrast to the results in Table 3, the longer payout phase in this scenario (22 years versus 12 years in the Table 3 scenario) is sufficient to result in larger end-of-payout phase balances, the account balance at the end of the payout period for the respective scenario, (by about 6.5%) for the TDF with Traditional compared to the TDF without Traditional.

Eight of the nine scenarios we consider have payout duration between 17 and 27 years, which bracket the realistic life expectancy of a 65-year-old.[11] The comparison of the three scenarios in Tables 2–4 span the overall results. They show that the TDF with Traditional will outperform the TDF without Traditional for normal life expectancies and higher even when the immediate interest rates available at annuitization are high relative to the blended Traditional accumulation rate.

11 For the 2019 Social Security Administration Life Tables, life expectancy at age 65 was 18.09 and 20.70 years for males and females, respectively. See: https://www.ssa.gov/oact/STATS/table4c6_2019_TR2022.html

TABLE 4. SCENARIO ILLUSTRATING THE IMPACT OF A LONGER PAYOUT PERIOD

TDF Risk Profile:	Moderate
Scenario:	5
Start of Accumulation Phase:	1/1/1975
Start of Payout Phase:	1/1/2000
Years in Accumulation Phase:	25
Years in Payout Phase:	22
End of Payout Phase:	12/31/2021
Total Contributions:	$152,654
Total Annuity Payout:	$334,166
TDF:	TDF with Traditional RA
Annuity IRR (Traditional)	**7.09%**
Annuity IRR (no Traditional)	**6.59%**

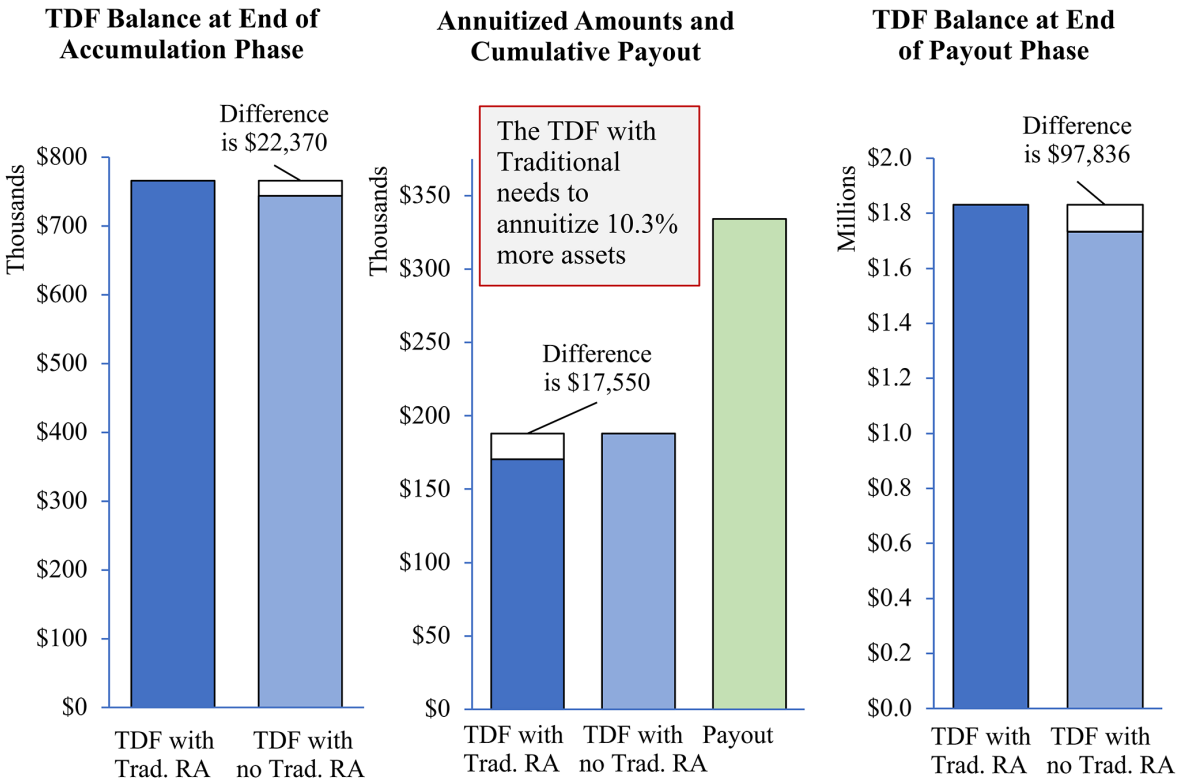
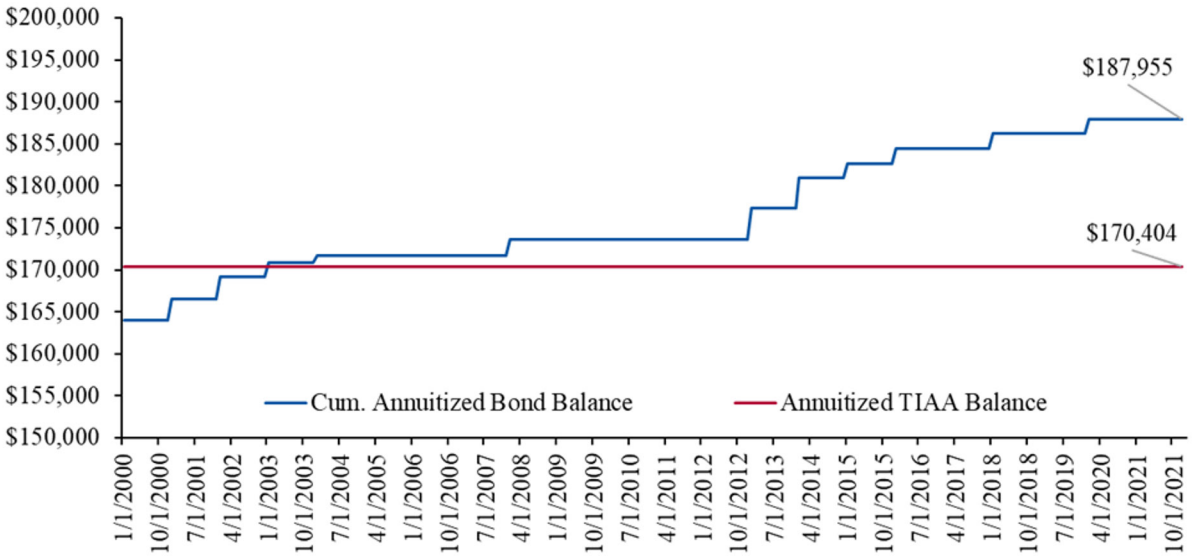
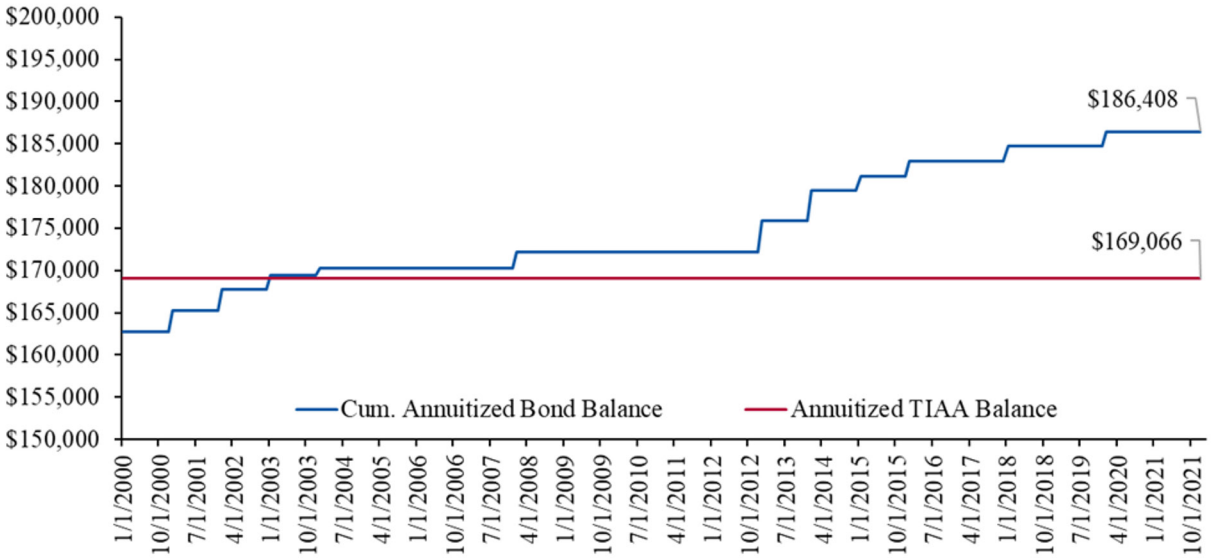


FIGURE 4. LONGER PAYOUT PERIOD SCENARIO: CUMULATIVE ANNUITIZED BOND BALANCE VERSUS ANNUITIZED TIAA BALANCE (SCENARIO 7 WITH MODERATE PROFILE)

Tab A: TDF with RA



Tab B: TDF with SRA



In Tables 5 and 6 below, we report the internal rates of return (IRRs) achieved by annuitizing the entire Traditional balance at retirement versus annuitizing sums from the TDF without Traditional to match the income. The IRR is the annual rate of return that balances the investments made with the payouts received. Table 5 reports the TDF with RA analyses and Table 6 the TDF with SRA analyses. Both show the results for all nine scenarios in the Conservative, Moderate, and Aggressive TDF glideslopes, respectively.

The most striking result is that the IRRs from TDFs with Traditional are higher than those without Traditional in **every scenario** in Tables 5 and 6. The primary reason for this result is that the TDF without Traditional must continue to annuitize additional amounts during the payout period to match the growing income stream during retirement offered by the RA/SRA. For the TDFs with RA Traditional (Table 5), the IRR differences range from 0.4% to 1.67%. The differences using SRA are very similar to those in Table 5. On average, the advantage is 1.18%.

The impact of this growing payout was illustrated in the scenarios in Tables 2 through 4, which show that matching the RA income requires the TDF without Traditional to annuitize an additional 15.1%, 2.9%, and 27% of its assets, respectively. Over the 27 scenarios, the TDFs without Traditional must annuitize an extra 16% of their assets on average to match the payouts of the RA or SRA.[12]

Longer payout periods will result in higher IRRs regardless of whether Traditional is used or the participant relies on immediate annuitization at market rates. Annuities offer longevity protection, and the return from investing in them will increase as the payout period lengthens. The dominance of the annuity IRRs for TDFs with Traditional irrespective of payout period length and differences in the market interest rate environment also illustrates the advantages of accumulating with TIAA Traditional to obtain the blended return of the vintages over time.

12 Details for each scenario are available in the Appendix.

TABLE 5. INTERNAL RATES OF RETURN FOR ANNUITY PAYOUTS—TDF WITH TRADITIONAL RA

Scenario	Accum. Period (Years)	Payout Period (Years)	Annuity IRR		Difference
			TDF with Traditional RA	TDF without Traditional	
CONSERVATIVE TDF					
1	30	19	5.52%	3.87%	1.65%
2	25	24	8.28%	6.61%	1.67%
3	22	27	9.22%	7.85%	1.37%
4	30	17	3.55%	2.15%	1.40%
5	25	22	7.19%	6.59%	0.60%
6	22	25	8.57%	7.12%	1.45%
7	30	12	-2.94%	-3.52%	0.58%
8	25	17	3.48%	2.14%	1.34%
9	22	20	6.53%	5.32%	1.21%
MODERATE TDF					
1	30	19	5.43%	3.86%	1.57%
2	25	24	8.20%	6.62%	1.58%
3	22	27	9.14%	7.85%	1.29%
4	30	17	3.51%	2.14%	1.37%
5	25	22	7.09%	6.59%	0.50%
6	22	25	8.50%	7.12%	1.38%
7	30	12	-3.04%	-3.52%	0.48%
8	25	17	3.45%	2.14%	1.31%
9	22	20	6.49%	5.32%	1.17%
AGGRESSIVE TDF					
1	30	19	5.36%	3.86%	1.50%
2	25	24	8.14%	6.62%	1.52%
3	22	27	9.07%	7.86%	1.21%
4	30	17	3.42%	2.14%	1.28%
5	25	22	7.01%	6.59%	0.42%
6	22	25	8.45%	7.13%	1.32%
7	30	12	-3.12%	-3.52%	0.40%
8	25	17	3.38%	2.14%	1.24%
9	22	20	6.46%	5.32%	1.14%

TABLE 6. INTERNAL RATES OF RETURN FOR ANNUITY PAYOUTS—TDF WITH TRADITIONAL SRA

Scenario	Accum. Period (Years)	Payout Period (Years)	Annuity IRR		Difference
			TDF with Traditional SRA	TDF without Traditional	
CONSERVATIVE TDF					
1	30	19	5.51%	3.87%	1.64%
2	25	24	8.28%	6.52%	1.76%
3	22	27	9.22%	7.85%	1.37%
4	30	17	3.54%	2.15%	1.39%
5	25	22	7.18%	6.59%	0.59%
6	22	25	8.57%	7.12%	1.45%
7	30	12	-2.95%	-3.52%	0.57%
8	25	17	3.48%	2.14%	1.34%
9	22	20	6.53%	5.32%	1.21%
MODERATE TDF					
1	30	19	5.43%	3.86%	1.57%
2	25	24	8.20%	6.62%	1.58%
3	22	27	9.14%	7.85%	1.29%
4	30	17	3.49%	2.14%	1.35%
5	25	22	7.08%	6.59%	0.49%
6	22	25	8.50%	7.12%	1.38%
7	30	12	-3.05%	-3.52%	0.47%
8	25	17	3.44%	2.14%	1.30%
9	22	20	6.49%	5.32%	1.17%
AGGRESSIVE TDF					
1	30	19	5.36%	3.86%	1.50%
2	25	24	8.14%	6.62%	1.52%
3	22	27	9.07%	7.86%	1.21%
4	30	17	3.40%	2.14%	1.26%
5	25	22	7.01%	6.59%	0.42%
6	22	25	8.45%	7.13%	1.32%
7	30	12	-3.12%	-3.52%	0.40%
8	25	17	3.37%	2.14%	1.23%
9	22	20	6.45%	5.32%	1.13%

The dominance of the TDFs with Traditional RA and SRA is also a function of the advantages of Traditional relative to fixed income mutual funds. During accumulation, the crediting rates of the TIAA Traditional RA and SRA tend to be higher than intermediate bond fund returns (see Babbel et al., 2022). In the TDF without Traditional, intermediate bonds constitute 50% of the fixed income sleeve and long-term corporate/government the other 50% (see Section II above). Substituting TIAA Traditional for a portion of the bond sleeve thus leads to larger returns (as well as lower risk).

As indicated above, we require the total payout amount to be the same for the TDFs with and without Traditional. Risk profiles impact total payout: Tables 5 and 6 both show that as the risk profile becomes more aggressive, the total payout decreases for any given scenario. This is a consequence of the glidepath allocations, whose weights for fixed income and TIAA Traditional get smaller as the risk profile becomes more aggressive. The tradeoff for higher risk profiles is a larger end-of-payout balance for any given scenario.

For the payout period analysis, we annuitize the entire TIAA Traditional balance in the TDF with Traditional at retirement and the amounts necessary from the TDF without Traditional to generate the same stream of monthly payouts during the entire payout phase. This does not mean, however, that additional amounts from the TDF with or without Traditional could not be annuitized during the payout phase. But since we annuitize the entire TIAA Traditional balance at retirement, there would be no difference in the payouts coming from additional annuitization of either TDF, with or without Traditional.

The appendix shows detailed information about the end-of-accumulation and end-of-payout period balances for all 27 scenarios. On average, TDFs with the RA contract have significantly greater end-of-accumulation values compared to the TDF without Traditional in 93% (25 out of 27) of the scenarios we examine. The TDF with SRA contract accumulation results are also positive relative to the TDFs without Traditional, with end-of-accumulation values greater in 17 of the 27 scenarios. TDFs must continue to annuitize assets to match the growing income stream Traditional provides during the payout phase, so the advantages of Traditional continue to increase throughout the life cycle. TDFs that had accumulated with Traditional RA/SRA have significantly greater residual balances than those without Traditional, averaging more than $100K/$88K difference (6.5%/5.5%) over the 27 scenarios we examine. Ending period balances of the TDF with Traditional RA (SRA) are higher in 26 (23) of the 27 scenarios.

3. Income replacement percentages

In this analysis we estimate the percentage of participant earned income that is replaced with the complete annuitization of the TDF TIAA Traditional annuity component at retirement. The metric we use is the income replacement percentage (IRP) of last year's salary, defined as the ratio of the annual annuity payment for the first payout phase year to the end year accumulation phase salary.

Ideally, we would like to consider accumulation periods of 30 years and payout periods with a length close to 20 years of life expectancy at retirement. This is not possible with the 49 years of data available (when restricted to the SRA) and, therefore, we focus on 30-year accumulation periods and the annual annuity payment (or payout) over the first payout phase year.

Our analysis considers the full extent of loyalty bonus data given the 30-year accumulation periods. Our estimates of the IRP, however, could be viewed as conservative. They are computed based on the year-one payout, and do not consider the impact of increasing annuity payouts during the distribution phase.

We use ending-year salaries for full-time instructional faculty in four-year public institutions as compiled by the National Center for Education Statistics (NCES).[13] The table below reports the starting and ending salaries. It also reports starting monthly contributions and total contributions during the accumulation phase, when the assumed contribution rate is 15% of salary.

13 We estimate starting salaries using current data and a 3% average annual cost of living increase.

The five 30-year accumulation periods examined are:

	Starting Salary		Ending Salary		Contributions (15% of Salary)	
Accumulation Period	Year	Salary	Year	Salary	Starting	Total
1	1973	$26,220	2002	$63,486	$328	$189,672
2	1974	$26,573	2003	$64,340	$332	$192,224
3	1976	$28,064	2005	$67,951	$351	$203,012
4	1981	$31,742	2010	$76,857	$397	$229,620
5	1987	$35,358	2016	$85,612	$442	$255,777

The focus in this section is on examining different 30-year accumulation periods and computing the corresponding IRPs in the first year of retirement. The calculations of performance for both TDFs, with and without Traditional, are based on the same model with annual rebalancing as was used in the previous section.

We report results for the IRPs for each of these accumulation periods, including the Conservative, Moderate, and Aggressive risk profiles. Importantly, we also report the main factors that are associated with IRPs:

1. First-year annuity payout rates
2. Average annual blended portfolio returns
3. Portfolio shares of TIAA Traditional at annuitization. Note that these shares vary due to the timing of last positive-only rebalancing.

Table 7 reports income replacement ratios and determining factors for all accumulation periods and risk profiles considered in this section. IRPs for the SRA are slightly below those for the RA, normally less than one percentage point.[14]

14 Detailed calculations are available in the Appendix.

TABLE 7. INCOME REPLACEMENT PERCENTAGES AT 15% CONTRIBUTION RATE—RA

Accumulation Period	Ending Accumulation Phase Balance	First Year Annuity Payout	Amount Annuitized	Blended Average Annual Return	TIAA Trad. Share at Annuitization	First-Year Payout Rate	Income Replacement Ratio
TDF RISK PROFILE: CONSERVATIVE							
1	$871,274	$26,834	$330,520	9.37%	37.94%	8.12%	42.27%
2	$991,580	$23,299	$303,663	10.58%	30.62%	7.67%	36.21%
3	$977,637	$20,985	$289,612	10.76%	29.62%	7.25%	30.88%
4	$843,000	$16,679	$251,668	9.59%	29.85%	6.63%	21.70%
5	$800,542	$14,408	$220,741	8.24%	27.57%	6.53%	16.83%
TDF RISK PROFILE: MODERATE							
1	$914,191	$24,784	$307,361	9.59%	33.62%	8.06%	39.04%
2	$1,058,530	$20,784	$273,297	11.00%	25.82%	7.60%	32.30%
3	$1,025,225	$17,596	$244,060	11.18%	23.81%	7.21%	25.89%
4	$878,618	$14,988	$227,724	9.83%	25.92%	6.58%	19.50%
5	$832,846	$12,506	$195,971	8.47%	23.53%	6.38%	14.61%
TDF RISK PROFILE: AGGRESSIVE							
1	$949,985	$23,281	$290,200	9.75%	30.55%	8.02%	36.67%
2	$1,124,893	$19,174	$254,012	11.35%	22.58%	7.55%	29.80%
3	$1,089,783	$16,196	$226,445	11.58%	20.78%	7.15%	23.83%
4	$899,944	$13,577	$207,448	9.97%	23.05%	6.54%	17.67%
5	$852,736	$10,960	$174,797	8.60%	20.50%	6.27%	12.80%

A regression of the IRPs in Table 7 on the three factors we have singled out above gives a near perfect fit as seen in the table below, for the RA. Results for the SRA are very similar:

	First-Year Payout Rate	TIAA Trad. Share at Annuitization	Blended Average Annual Return	Intercept
15% CONTRIBUTION RATE				
Estimate	**10.3844**	**0.6016**	**1.3238**	**-0.7730**
Std. Error	**0.6824**	**0.0824**	**0.3257**	**0.0289**
R^2	**99.33%**	0.0087		
	544.0594	11		
	0.1239	0.0008		
T-Stats	**15.218**	**7.302**	**4.064**	**-26.794**

The single most important factor is the first-year payout rate, as is to be expected, with the most impact and highest significance. Our five accumulation periods, with start dates from 1973 through 1987, show a monotone decline in first-year payout rate in line with the trend toward lower interest rates over the sample period. To put the differences in interest rates in context, the 10-year Treasury rates in 1973 were about half what they were by 1980 (7% versus 14%, respectively). From 1980 to 2020, 10-year rates declined in a largely monotone manner from 14% to 0.6%. Reflecting this pattern, the decline in annuity payout rates over this time is quite large. For example, Table 7 shows that the Conservative RA case, Scenario 1 (1973–2002) has an 8.12% payout rate while Scenario 5 (1987–2016) has a 6.53% payout rate. The decline in payout rates of approximately 20% that is associated with the change in start date from 1973 to 1987 is observed across all TDF risk profiles. In Table 7, the corresponding decline in IRPs from 1973 to 1987 is approximately 25%. This is consistent with the regression results showing the statistical importance of payout rate in explaining IRPs.

We also note that the risk profile is captured by the blended portfolio rates. When we extend the regression of IRPs to include indicator (dummy) variables for the Moderate and Aggressive risk profiles, they are statistically insignificant. As expected, IRPs decline monotonically as the risk profile moves from conservative to aggressive, with declines in income over the five 30-year accumulation periods ranging from about 15–30%. The tradeoff is that the TDFs with Traditional with higher risk profiles tend to have higher end-of-accumulation balances than the lower risk profiles. The direct comparison of those balances, however, is inappropriate without a control for risk.

We should note that the IRPs reported in Table 7 are independent of the salary amounts used in our analysis. Of course, these amounts determine the level of the payouts, as do COLA factors and contribution rates. But IRPs are not dependent on levels of salaries. The contribution rate does affect the IRPs in direct proportion to the percentage difference in the percentage being computed. For example, the IRP from a contribution rate of 15% will be 1.25 times higher than a contribution rate of 12% (15/12).[15]

4. Discussion and concluding remarks

The life cycle analysis of 27 scenarios spanning 49 years of data clearly shows the benefits of adding TIAA Traditional to a TDF. In all but the shortest payout scenarios, the TDFs with Traditional shows a distinct advantage in end-of-payout period wealth over a comparison TDF without Traditional. While the TDFs with Traditional often have end-of-accumulation balances higher than those without Traditional, the lifecycle advantage accrues mainly from the increases in payments in retirement offered by TIAA Traditional that must be matched by selling assets from TDFs that did not have Traditional.

The payout phase results highlight the benefits of longevity risk protection that TIAA Traditional offers participants. The Scenario 7 results show a TDF with/without Traditional breakeven payout phase length of about 12 years (2010–2021). Longer payout periods strongly benefit the TDF with Traditional. With life expectancies of approximately 20 years, contingent upon reaching normal retirement age, the TDF with Traditional is clearly a superior choice for most participants.

The results also clearly illustrate that a retirement structure offering only investment (mutual fund) products cannot be directly compared to one that offers annuity options. Merely comparing end-of-accumulation period results is fundamentally flawed theoretically and empirically, as the results in this paper show.

The IRP results build on the life cycle analysis by highlighting several important policy issues. TDFs have become increasingly popular since the PPA of 2006. As a default, they tend to be used by participants with less financial acumen and/or less interest in personally managing their DC retirement plan. To the extent that these are also individuals who earn relatively low income compared to others in the plan, we can extrapolate the IRP results by including expected Social Security benefits. In a 2022 policy brief, the Center on Budget and Policy Priorities (CBPP) estimates Social Security replaces 37% of income for a covered worker with average earnings over their lifetime. Social Security IRPs are progressive, with low earners receiving an estimated 45% and high earners 30%.

Combining the Social Security IRPs with those from TIAA Traditional annuitization (presented in Section III above) presents some interesting outcomes. While Social Security IRPs are progressive, the Traditional IRPs are not. They are, however, a direct function of the percentage of salary (including any match) invested. At a 15% contribution level, median IRP over the five scenarios in the RA contract is approximately 30%.[16] Using the low-, average-, and high-

15 Additional details and regressions of the 12% scenario are available in the Appendix.

earner profiles leads to a total IRP of 75%, 67%, and 60%, respectively. These IRPs are very close to those estimated to preserve a standard of living in retirement amongst low- and middle-income participants (Aon Consulting, 2008). With lower levels of wealth entering retirement, these low- and middle-income participants would also be the most challenged when trying to finance a longevity-protected income stream by periodically selling mutual fund assets in their DC plan during the payout phase.

Calculating an IRP at retirement could be considered conservative in the sense that future increases in both the TIAA Traditional payout (from sharing excess profits) and in Social Security payouts (based on inflation) are ignored. Inflation in retirement can be a significant challenge, however, given that larger amounts are typically spent on services like leisure and healthcare. On balance, the increasing stream of payouts offered by TIAA Traditional helps the participant better than the traditional fixed annuity. This is shown in all scenarios where the TDF without Traditional must continue to annuitize assets during the payout phase to match the income from TIAA Traditional.

The TDF with Traditional thus provides a structure that addresses not only asset accumulation but also longevity-protected income provision in retirement. The structure is thus an extension of the choice architecture innovations offered by authors like Thaler, Sunstein, and Benartzi. While the decision to annuitize the entire Traditional balance at retirement will be made at that time, the participant will have had the benefit of linking the Traditional component of their plan with income throughout the accumulation phase. The restrictions imposed on any sale of Traditional within the TDF glidepath reinforce the benefit of choice architecture-driven commitment devices. The literature in behavioral economics has shown that contract design can benefit time-inconsistent individuals (e.g., DellaVigna & Malmendier, 2004; Heidhues & Kőszegi, 2010). The DC plan setting is especially challenging for participants with an investment-centric focus as assets being accumulated for retirement can (and often are) liquidated for other purposes.

We illustrate the benefits of delayed liquidity by the comparison of the TDFs with RA and SRA. While both TDFs dominate the corresponding TDF with no Traditional, the TDF with Traditional RA has slightly greater dominance. This is due to the higher accumulation interest rates of the RA compared to the SRA, these higher interest rates are in exchange for delayed liquidity, including no lump-sum withdrawals. Thus, the participant commitment to a delayed liquidity product has future lifetime income benefits Thus, the participant commitment to forego lump-sum withdrawals has life cycle benefits.

The "double-default" structure of annuitizing the entire TIAA Traditional balance at retirement still leaves about three-quarters of the assets in place (on average across 27 scenarios). As such, it addresses "annuity puzzle" challenges associated with concerns about lack of liquidity to meet unexpected future obligations, bequest motives, and dying "too early."

16 In the context of university plans, required contributions plus matches are often in the 12–15% range.

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