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ARTICLE

Target-date funds and portfolio choice in 401(k) plans

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Abstract

Target-date funds in corporate retirement plans grew from $5 billion in 2000 to $734 billion in 2018, partly because federal regulation sanctioned these as default investments in automatic enrollment plans. We show that adopters delegated pension investment decisions to fund managers selected by plan sponsors. Inclusion of these funds in retirement saving menus raised equity shares, boosted bond exposures, curtailed cash/company stock holdings, and reduced idiosyncratic risk. The adoption of low-cost target-date funds may enhance retirement wealth by as much as 50% over a 30-year horizon.

Keywords: automatic enrollment; default effect; endorsement effect; pension; portfolio allocation; retirement saving

JEL codes: D12; D14; D91; G41; G51; J32

Although plan sponsors are legally responsible for selecting and overseeing investment options in a 401(k) plan, employees have traditionally borne the responsibility for making their own portfolio construction decisions.[1] Indeed, 401(k) plans have anecdotally been described as requiring workers to become their own portfolio managers. One concern with this state of affairs has been that, due to financial illiteracy or behavioral biases, many participants appear to be ill-equipped to make these portfolio decisions, potentially undermining old-age retirement security.[2]

This paper illustrates how the introduction of target-date funds (TDFs) into 401(k) plans has fundamentally altered this decision-making dynamic. A TDF menu consists of a series of fund offerings with portfolio allocations described in terms of an expected year of retirement; usually offered in 5-year increments (e.g., 2015, 2020, etc., fund); a TDF series may include up to a dozen funds. Participants in voluntary choice plans must make active investment decisions among target date and other fund offerings; participants in automatic enrollment plans are initially defaulted into a single TDF based on the employee's current age and assumed retirement date (usually age 65), with the option to move subsequently to other investments. TDF assets in 401(k) plans have grown dramatically over time: from $5 billion in 2000 to $734 billion in 2018 (ICI, 2019). This growth was spurred in part by a Department of Labor regulation issued under the 2006 Pension Protection Act designating TDFs as an eligible default investment option for automatic enrollment plans.[3] By 2018, 80% of 401(k)

[1]Here we use the term 401(k) plans to refer broadly to private-sector defined contribution plans which can include profit-sharing, money purchase, and 403(b) plans along with 401(k) plans.

[2]Research on the role of financial illiteracy or behavioral biases in investing and savings decisions includes Bekaert et al. (2017); Benartzi and Thaler (2001, 2002); Beshears et al. (2018); Goda et al. (2020); Lusardi and Mitchell (2007, 2011, 2014); Mitchell and Lusardi (2011); Mottola and Utkus (2008); and van Rooij et al. (2011).

[3]The Department of Labor regulations were effective December 24, 2007. 72 Fed. Reg. 60451. Eligible 'qualified default investment alternatives' (QDIAs) include TDFs, traditional balanced funds, and managed account advice services. QDIA regulations provide sponsors so-called 404(c) protection for participant portfolio choices, meaning there is a presumption that

plans offered these funds (ICI, 2019), and two-thirds of 401(k) new plan entrants were automatically enrolled, with target funds the dominant choice for default investments by plan sponsors (Vanguard, 2019). This greater U.S. reliance on automatic enrollment and default portfolio choice is consistent with the global move toward default portfolio choice in defined contribution systems (OECD, 2015).

Compared to other multi-asset class portfolios, such as traditional balanced funds or risk-based lifecycle funds, TDFs offer two unique advice-related features. First, each fund is identified with an anticipated retirement year, which serves as an implicit recommendation regarding which types of investors should hold each fund. When investors must make their own portfolio choices, the date labeling transforms a potentially complex decision about how to assemble a portfolio with the available funds on the menu into a simpler decision heuristic, namely portfolio allocation based on an anticipated retirement date. Second, target-date risk levels are automatically rebalanced over time by a fund manager who follows an 'equity glide path', reducing risk as participants near their target dates. Prior to the advent of TDFs, no investment fund provided age-related rebalancing in 401(k) plans.[4]

This paper evaluates how the introduction of TDFs into 401(k) investment menus reshapes portfolio choice decisions by participants, drawing on an anonymized, restricted-access longitudinal dataset from Vanguard, a major 401(k) plan administrator and investment manager. The TDFs in our sample are almost exclusively indexed portfolios, diversified across global equity and fixed asset classes, with management fees of below 20 basis points. As of 2020, indexed strategies were the dominant target data strategy in the marketplace, representing just over half of all target data industry assets.[5] As a result, our dataset represents a real-world benchmark for the provision of low-cost, highly diversified professional portfolio advice to an important group of nonprofessional investors.

Our approach is to estimate participant adoption and portfolio exposures 1 year after the first appearance of the funds in a 401(k) investment menu; that is, we measure their early impact. In terms of behavioral effects, we estimate that 28.4% of new entrants into voluntary enrollment plans adopted TDFs as part of their portfolios, whereas only 10.2% of existing employees (workers in the plan prior to the funds' appearance) switched from existing investments to the funds. This difference we describe as an *active choice effect*, reflecting the fact that new entrants in voluntary enrollment plans had to make an active choice to join the 401(k) plan, whereas existing employees faced a discretionary choice of whether to switch to new options.

In contrast, in plans with new-hire automatic enrollment, 78.7% of new entrants adopted TDFs, representing a substantial *default effect*. In addition, 21.7% of existing employees in these plans invested in the funds, double the rate of existing employees in voluntary choice plans. We take this latter result as a *default-related endorsement effect*: the employer's selection of TDFs as a default investment for new hires influenced existing employees' willingness to switch to these funds. Similar effects are observed for other measures, such as the propensity to be a *pure target-date investor* (investing all of one's savings in a single TDF) or a *mixed target-date investor* (combining a TDF with other options).

In terms of portfolio effects, the adoption of TDFs had sizeable effects on equity share and risk factor exposures. Equity share rose an average of 24 percentage points for pure investors, and by 13 percentage points for mixed investors, both relative to non-target-date investors. Pure and mixed target-date investors' equity share also declined with age, whereas non-target-date investors had a

employers are not liable for participant portfolio decisions when participants hold QDIAs. The sponsor retains liability for selecting and monitoring the QDIA itself.

[4]A declining equity share with age is based on arguments about labor income (e.g., Viceira, 2001; Campbell and Viceira, 2002; Cocco et al., 2005) but has also been criticized as sub-optimal (e.g., Basu et al., 2011).

[5]According to Morningstar (2021), total indexed target date assets amounted to $1.5 trillion among the top ten providers in 2020, in both mutual fund and collective trust format, versus total target date assets of $2.8 trillion. As noted by Balduzzi and Reuter (2019), the industry is characterized by a wide level of heterogeneity in investment approaches. We would anticipate therefore that our results using Vanguard funds will be relevant to participants offered by other index-based providers, though results could differ for people offered higher-cost active strategies. The direction of the difference is unclear, with some participants dissuaded by higher fees and others attracted by active management.

hump-shaped equity share by age. As a result of increased equity and bond market exposures, expected factor returns for pure investors rose by 2.3% per year and for mixed investors by 1.7% per year, relative to non-target-date investors. Holdings were reduced in cash and company stock and, in our sample of indexed TDFs, uncompensated idiosyncratic risk fell.

The use of TDFs signals an important shift away from participants' own-portfolio choice in 401(k) plans, to the delegation of critical portfolio decisions by workers to the target-date manager selected by the employer. This change has potentially sizeable benefits. We estimate that, for a pure investor in a low-cost target-date series, higher returns would raise expected retirement wealth by as much as 50% over a 30-year saving horizon.[6] Given employer and participant selection effects – in particular, employers may have introduced the funds in response to concerns over the quality of participant portfolio construction – we cannot assert that these results are the causal 'treatment effects' of target-date lifecycle advice. Yet it is also true that adopters of the funds could have made these changes on their own and realize these potential benefits – but they chose not to, until the arrival of TDFs. Finally, these findings underscore the potential benefits that the provision of scalable low-cost investment advice might offer to other groups of nonprofessional investors.[7]

Our paper is related to an extensive literature examining how default arrangements influence employee savings and investment decisions.[8] A related body of research has asked whether individual portfolio choice is influenced by investment illiteracy or behavioral biases.[9] Our research is linked to those studies as well as analyses showing that retirement investment menus can shape, or 'frame,' portfolio allocation patterns due to inertia or naïveté,[10] or in reaction to excessive complexity (also known as 'choice overload').[11] As target-date funds have increased their presence in 401(k) plans, there is also an emerging body of work on their differing strategies, relative performance, and equilibrium effects on stock and bond prices.[12] Our contribution is to show how introducing TDFs into the 401(k) investment set substantially altered portfolio outcomes across a diverse set of firms in voluntary choice and automatic enrollment settings.

In what follows, we describe how plan choice architecture shaped participant portfolio outcomes. We then turn to an empirical analysis of adoption behavior and the change in portfolio composition. We conclude with a discussion of implications of our findings for household finance and for the potential benefits that scalable, low-cost investment advice can provide.

401(k) choice architecture and participant portfolio choice

Our analysis draws on administrative records for 880 defined contribution plans that introduced TDFs between January 2003 and June 2015 (a period of 12.5 years or 150 months). These data were provided

[6]Higher exposure to equities also raises wealth volatility, most notably among participants at younger ages. Whether higher expected wealth is ultimately welfare-improving will depend upon a specification of participant' utility function over the lifecycle; that exercise is beyond the scope of this paper.

[7]For example, besides providing the risk-taking and diversification benefits noted here for target-date funds, low-cost investment advice could potentially reduce heterogeneity of returns and wealth differences among households (Campbell et al., 2019) or address concerns about bias among traditional commission-based advisers (Inderst and Ottaviani, 2012).

[8]On the savings side, see Carroll et al. (2009); Choi et al. (2004a); Choi et al. (2003, 2004b, 2006); Clark and Young (2018); and Madrian and Shea (2001). On portfolio allocation, see Agnew et al. (2003); Ameriks and Zeldes (2001); Benartzi (2001); Benartzi and Thaler (2001, 2002); Benartzi et al. (2007); Calvet et al. (2009); Mitchell et al. (2006a, 2006b); and O'Donoghue and Rabin (1999; 2001).

[9]See Barber and Odean (2001); Bekaert et al. (2017); Benartzi and Thaler (2001, 2002); Beshears et al. (2018); Goda et al. (2020); Lusardi and Mitchell (2007, 2011, 2014); Mottola and Utkus (2008); Mitchell and Lusardi (2011); and van Rooij et al. (2011).

[10]Examples include Agnew and Szykman (2005); Elton et al. (2007); Huberman and Jiang (2006); Brown et al. (2007); McDonald et al. (2019); Thaler and Sunstein (2008); Tang et al. (2010); and Pool et al. (2016).

[11]See for example Iyengar et al. (2004) and Iyengar and Kamenica (2010).

[12]Balduzzi and Reuter (2019), Brown and Davies (2020), Massa et al. (2020). Parker et al. (2020), and Shoven and Walton (2020).

by Vanguard, a leading U.S. 401(k) recordkeeper, on an anonymous, restricted-access basis. All TDFs in the sample offered were Vanguard-managed. Table 1 illustrates how the TDFs relate to their target maturity dates, and it also indicates how each fund utilizes a different mix of passively managed U.S. equity (including large-, mid- and small-capitalization stocks), international equity (both developed and emerging markets), and high-quality domestic bonds.[13] For instance, total equity exposure in the funds for young participants (third column in Table 1) averaged 90% (in the 2040 through 2055 funds), versus 30% for participants in the income fund (intended for retirees).[14]

To analyze TDF portfolio choice, we selected a research sample of over 1.2 million active participants from the 880 plans introducing TDFs between January 2003 and June 2015.[15] Both adoption and portfolio composition statistics were gathered for each plan 12 months following the first appearance of TDFs in the investment menu. Plan participants in the firm prior to the adoption of TDFs and still in the plan 1 year later were classified as *existing participants*; those entering the plan after the TDF introduction date and still in the plan at the 12-month window were classified as *new entrants*.

This distinction is important for understanding portfolio choice decisions. When TDFs first arrive in the menu, existing participants must decide whether they would switch their portfolio allocations from funds previously selected. Factors influencing their decisions could include the appeal of the key features of TDFs, namely their labeling as a form of investment advice and their automatic age-based rebalancing feature. Behavioral elements, such as inertia and procrastination, as well as an endowment effect (whereby funds already owned may appear to be more valuable than those not yet owned), may hinder adoption. By contrast, new entrants are likely to be more strongly influenced by a plan's choice architecture. In voluntary choice plans, new entrants making investment decisions must possess some degree of financial literacy to navigate through the entire plan investment menu, compare TDFs relative to other options, and construct their portfolios on their own. Auto-enrolled new entrants, by contrast, are directly invested in a single target date. Their choice is to take no action and remain in the single TDF assigned to them, or undertake a decision to switch to another portfolio with other characteristics.

Table 2 illustrates how the data can be grouped by plan and individual characteristics, using period average statistics.[16] Two key (0,1) variables indicate the plan choice architecture shaping participant choices: *TDFDefault*, indicating that the target-date series was designated as the plan's default option; and *New-hire auto enrollment*, indicating that the plan automatically enrolled new hires, regardless of the type of default fund used by the plan.[17] The first column in panel A reveals that 52% of participants were in plans where TDFs were the plan default.[18] One-third (32.9%) of participants were in plans where new hires were automatically enrolled in the firm's plan, regardless of the type of default

[13]In February 2013 the funds added an allocation of international bonds. We illustrate the allocations at the end of 2010 because they were typical of the period we study.

[14]The Vanguard funds are all indexed except for holdings of inflation-indexed bonds which were available to only a small fraction of retired participant portfolios; accordingly, we refer to the funds as indexed. Fees for the funds were below 0.20% during the 2003–15 period (at the end of our analysis period, even lower-cost versions of the TDFs were introduced in a handful of large plans). During 2010, a number of TDFs offered by other investment managers were introduced into the sample, but these accounted for under 1% of sample participants.

[15]Active 401(k) participants are those who are currently contributing to their employers' retirement plans. We only include plans for which we observe plan and participant records both prior to and subsequent to the introduction of the TDFs. Plans transferring to the Vanguard recordkeeping service for the first time during our sample period and adopting TDFs at that point are excluded from our sample because we cannot observe plan holdings prior to the funds' introduction.

[16]Our statistics are averages over the period for plan-specific 12-month windows, not end-of-period characteristics. Appendix Table 1 provides more detail on TDF patterns by year.

[17]Under new-hire automatic enrollment, newly eligible participants have contributions deducted automatically from their first eligible pay (with the right to opt out); their contributions are invested in the plan' designated default fund. Our automatic enrollment indicator is for new hires only. Some employers have 'swept' (i.e., automatically enrolled) existing eligible non-participants, because our dataset does not include an indicator for such 'sweeps'. Accordingly our estimates should be viewed as lower bounds.

[18]A plan may designate a fund as a default for several purposes, including automatic enrollment or as a fund for depositing administrative corrections.

Table 1. Target-date fund characteristics

TDF fund	Participant age in 2010	Equity allocation (%)	U.S. stocks (%)	Non-U.S. stocks (%)	U.S. nominal bonds (%)	U.S. inflation-protected bonds (%)	Cash (%)
2055	20	90	63.0	27.0	10.0	0.0	0.0
2050	25	90	63.0	27.0	10.0	0.0	0.0
2045	30	90	63.0	27.0	10.0	0.0	0.0
2040	35	90	63.0	27.0	10.0	0.0	0.0
2035	40	89	62.5	26.8	10.8	0.0	0.0
2030	45	82	57.2	24.5	18.3	0.0	0.0
2025	50	74	52.0	22.3	25.8	0.0	0.0
2020	55	67	46.7	20.0	33.3	0.0	0.0
2015	60	59	41.3	17.7	40.0	1.0	0.0
2010	65	49	34.0	14.6	40.4	10.7	0.4
2005	70	34	24.0	10.3	43.9	17.9	3.9
Income	75	30	21.0	9.0	45.0	20.0	5.0

Note: Fund asset mix measured as of December 2010.
Source: Authors' tabulations using Vanguard data; see text.

fund used. Panel A also indicates that 24.7% of participants became target-date investors with the advent of the new funds on the menu.[19] Two-thirds of these (15.7%) were pure target-date investors, contributing only to one TDF, while the remaining one-third (9%) were mixed investors, combined a TDF with other funds. The right side of Table 2 reports the percentage of pure, mixed, and non-target-date investors having the plan features indicated. For instance, 72.1% of pure investors were in plans where the TDFs were the default, and 49.5% of pure investors were in plans where new hires were auto-enrolled. By contrast, fewer participants holding mixed portfolios (64.9%) and only 46.3% of non-TDF investors were in plans where TDFs were the default. As also noted, plan menus averaged 25.6 funds in size, 48.4% of participants were offered employer stock as an investment option, and most employees (88.4%) had access to plan loans.

Turning to Panel B of Table 2, we see that 19.7% of participants were new entrants who joined their plans after TDF introduction, within the 12-month observation period.[20,21] Other participant information included 401(k) account balances and contribution patterns, plan investments, and participant characteristics such as age, sex, household income, job tenure, and non-retirement financial wealth.[22] In terms of target-date investor patterns, it is clear that pure target-date investors were younger and more likely to be female, had lower or moderate incomes, and held smaller account balances (second column, Table 2). Mixed TDF investors had the opposite characteristics and above-average balances (third column). Because the panel spanned by our data included the 2008–09 financial crisis period, we also include a variable indicating whether the 12-month plan window occurred during that period.

Adoption of target-date funds

To assess the distinct impacts of default versus active choice on participants' portfolio selection, we estimate three multivariate models of TDF adoption. Each model relates a distinct measure of target-

[19]Consistent with prior studies of participant investment behavior, we measure portfolio allocations using contribution designations rather than existing portfolio holdings, as the former better reflect forward-looking intentions.

[20]Not all new entrants are new hires: although most plans do allow new hires to become immediately eligible to contribute, a few impose a 6- or 12-month waiting period.

[21]The mean new entrant enrolled in his or her 401(k) plan after 5.8 months and the median after 6 months, while 94% of new entrants enrolled by month 11. In other words, most new entrants had a month or more to revisit initial investment decisions, particularly new entrants automatically enrolled into TDFs.

[22]Household income and non-retirement wealth were provided to Vanguard by Acxiom; amounts are imputed using zip code (zip+4) averages.

Table 2. Descriptive characteristics of plans and participants

	All	Pure TDF investors	Mixed TDF investors	Non-TDF investors
A. Plan features and participant outcomes (% of accounts)				
Choice architecture features				
TDF Default	52.0	72.1	64.9	46.3
New-hire auto enrollment	32.9	49.5	27.4	30.1
TDF adoption				
TDF investor	24.7	100.0	100.0	0.0
Pure TDF investor	15.7	100.0	0.0	0.0
Mixed TDF investor	9.0	0.0	100.0	0.0
Other plan features				
N funds offered (mean)	25.6	24.5	24.4	26.0
Employer stock offered	48.4	46.6	53.0	48.3
Loans offered	88.4	88.0	92.8	87.9
N plans	880	852	824	880
N unique accounts	1,262,506	198,242	114,161	950,103
B. Participant attributes (% of accounts)				
New entrants	19.7	54.5	24.2	11.8
Log account balance (2015$)	9.9	8.1	10.1	10.2
Job tenure (years)	10.0	5.0	8.7	11.3
Young (% <35)	25.1	41.3	28.2	21.4
Middle (% 35–55)	59.6	49.3	59.2	61.9
Old (% >55)	15.2	9.4	12.6	16.8
Male (%)	69.4	65.7	69.3	70.2
Low HH income (% <$62.5k)	31.0	37.9	27.0	30.0
Mid. HH income (% $62.5–$87.5 K)	26.7	28.9	26.9	26.2
High HH income (% >$87.5 K)	42.3	33.1	46.0	43.7
Low non-ret. fin. wealth (% <$7.3 K)	17.9	28.2	17.4	15.9
Mid. non-ret. fin, wealth (% $7.3 K-$61.2 K)	32.2	39.0	34.2	30.6
High non-ret. fin. wealth (% >$61.2 K)	49.9	32.8	48.4	53.6
Financial crisis (% of year)	8.1	8.6	10.1	7.8

Note: Post-TDF adoption sample; each individual observed 12 months after TDF introduction.
Source: Authors' tabulations using Vanguard data; see text and Appendix Table 3.

date adoption to default, participant, plan, and other factors, as in equation (1):

$$TDFAdoption_{i,j,t} = \alpha DEFAULT_{j,t} + \beta PLAN_{j,t} + \gamma PARTICIPANT_{i,t} + \nu_j + \tau_t + w_j + \varepsilon_{i,j,t} \quad (1)$$

Here, $TDFAdoption_{i,j,t}$ indicates whether employee i adopted a TDF in plan j in month t, measured using total contributions to the TDF (from both the employee and employer). Model A examines the extensive margin of target-date adoption by estimating a probit specification. Here, the dependent variable takes a value of 1 if the participant had contributed to a TDF a year after the introduction of TDFs in the plan menu (0 otherwise). The mean value of this time-weighted adoption rate was 24.7% over the 2003–15 period. Model B measures the intensive margin of adoption, where the dependent variable in the ordinary least squares (OLS) equation is the fraction of the employees' contributions directed to the TDF; the mean time-weighted value for our sample was 18.9% (which includes non-target-date investors).[23] Model C uses a multinomial logit framework where the dependent variable is equal to 0 if the participant was a non-target-date investor (the reference category); 1 if the participant was a 'mixed' TDF investor (directing 1–99% of contributions to one or more TDFs); or 2 if the participant was a 'pure' TDF investor (directing all contributions to a single TDF). In model C, the mean time-weighted proportion of pure investors was 15.7%, and of mixed investors, 9.0%.

All three models use the dataset summarized in Table 2 which includes all active participants in the 401(k) sample: a single monthly observation is available for each participant 12 months following the

[23]This figure includes both those holding TDFs and those with zero holdings.

first appearance of TDF in the plan menu. Explanatory variables in equation (1) include attributes of the plan default architecture, *DEFAULT*, discussed above, plus a *PLAN* vector of other characteristics such as the size of the plan menu, the availability of plan loans, and a comprehensive set of participant characteristics, *PARTICIPANT*, including age, sex, income, 401(k) account wealth, and a measure of non-retirement-account financial wealth.[24]

Rather than elaborating on each estimated coefficient separately (all are reported in Appendix Table 2), Table 3 uses these estimates to derive marginal effects for existing employees and new entrants under both voluntary choice and automatic enrollment architectures, holding all other explanatory variables at their sample means. The overall probability of adopting TDFs after 1 year averaged 24.7%. In voluntary enrollment plans, 10.2% of existing employees adopted these funds, versus a new entrant adoption rate nearly three times as large (28.4%). This sizeable difference is due to the fact that new plan entrants needed to make active choices in voluntary enrollment plans: they had to actively select investments to enroll in the plan, versus existing employees who had already enrolled and only needed to decide to make the switch to the new funds.

Within automatic enrollment plans, 21.7% of existing employees adopted the funds, as did 78.7% of auto-enrolled new entrants. The former result we interpret as due to the endorsement effect, whereby the employer's decision to choose the TDF as a default investment for new entrants influenced the willingness of existing employees to switch. It is more than twice as large as the adoption rate by existing employees in voluntary enrollment plans. The latter represents a very strong default effect. Panel 3 of Table 3 summarizes the relative sizes of these outcomes.

The second column of Table 3 addresses the fraction of contributions that employees direct to TDFs. The effects are similar in direction and magnitude to the first column. The third column shows that automatic enrollment was especially powerful in influencing participants to become *pure* target-date investors, another measure of the intensive adoption margin. Again, the same three effects are at work. In terms of the active choice effect, 3.9% of existing employees in voluntary choice plans switched all of their contributions to a single TDF when the funds were first introduced, while this figure rose to 14.5% for new enrollees. In terms of the default effect, 74.9% of automatically enrolled new entrants were pure target investors, more than five times the voluntary enrollment new entrant rate. And finally, in terms of the endorsement effect, only 3.9% of existing employees in voluntary plans switched to become pure investors, but this rate rose to 14.1% for existing employees in automatic enrollment plans.

Comparing the third and fourth columns also provides another lesson regarding the impact of plan choice architecture on portfolio choice. Specifically, new entrants to voluntary enrollment plans were roughly equally likely to be either pure (14.5%) or mixed (13.2%) TDF investors, whereas new entrants to automatic enrollment plans were five times more likely to be pure versus mixed investors (74.9 versus 17.2%).[25] One potential explanation for this difference is that employers who defaulted their participants into TDFs under automatic enrollment may have done so anticipating employee preferences for the age-based labeling or age-related rebalancing features unique to TDFs. An alternative explanation, consistent with the household finance literature on inertia and malleable preferences in financial decision-making, is that the default effect is very strong and overrides participant demand for mixed investments.

Our default-related adoption effects across 880 firms are similar in magnitude to prior individual company case studies of automatic enrollment (Madrian and Shea, 2001; Choi *et al.*, 2003, 2004b),

[24]The models also control for plan-level heteroskedasticity by clustering standard errors at the plan level (v_j), time fixed effects (τ_t), and industry fixed effects, along with missing data dummies. All models also include a financial crisis control, defined here as the period September 2008–June 2009.

[25]Both Agnew et al. (2012) and Ameriks et al. (2011) have reported that some participants select a mixed strategy, believing that this enhances diversification; in other words they fail to recognize that each TDF is already a highly-diversified multi-asset-class fund. This view may reflect a naïve understanding of diversification or a desire to diversify across multiple managers. Pagliaro and Utkus (2017a) demonstrate how different types of mixed investors diversify their portfolios, including those who alter risk levels and active/passive share.

Table 3. Summary of marginal effects of plan choice architecture on target-date fund adoption

In percent	Probability of TDF adoption (1)		Total contributions to TDFs (2)		Probability of pure TDF (3)		Probability of mixed TDF (4)	
Sample mean	24.7		18.9		15.7		9.0	
Choice architecture								
I. Voluntary choice								
A. Existing employees	10.2	(1.2)	7.6	(1.2)	3.9	(0.6)	5.6	(0.6)
B. New entrants	28.4	(2.9)	27.4	(2.9)	14.5	(2.2)	13.2	(1.7)
II. Auto enroll of new entrants to TDF								
A. Existing employees	21.7	(3.0)	18.7	(2.3)	14.1	(2.6)	7.9	(1.4)
B. New entrants	78.7	(5.8)	73.2	(4.4)	74.9	(6.8)	17.2	(2.5)
III. Summary of effects								
Active choice effect (IB v.<versus> IA)	2.8		3.6		3.8		2.3	
Endorsement effect (IIA v. IA)	2.1		2.5		3.6		1.4	
Default effect (IIB v. IB)	2.8		2.7		5.2		1.3	

Note: Marginal effects derived from model estimates appearing in Appendix Table 2 (probit model of the probability of adoption; OLS model of total employer and employee contributions; and a multinomial logit model of pure versus mixed versus non-target date adopters), with all other variables held at sample means. Standard errors of marginal effects from fitted models in parentheses. 'New entrants' are participants who enrolled with TDFs available in the investment menu; 'existing participants' are those who enrolled prior to TDFs being introduced in the menu. Adoption effects are measured 1 year after the first TDF appearance in the menu.
Source: Authors' tabulations using Vanguard data; see text and Appendix Table 3.

where automatically enrolled new entrants remained entirely in the default fund, at rates ranging from 46% to 90%. Their results differ from ours due to firm-specific design factors, different methods of measurement, and, in most cases, the fact that default funds tended to be low-risk money market funds. Other results on voluntary choice are not directly comparable to ours as their case studies measured the effects of a default fund that had previously been included in the menu as a voluntary enrollment option, unlike in our setting where we focus on the first appearance of TDFs in the menu. Our measured endorsement effects are meaningfully higher than other reported results. For example, Benartzi (2001) found that employees were over one-and-a-half times more likely to invest their own contributions in employer stock when the employer match to their account was in stock rather than cash (29% versus 18%).[26] In our results, the endorsement effect is associated with a two to nearly four times higher propensity to hold TDFs by existing employees, depending on the exact measure. Moreover, the endorsement effect we measure comes from a default designation affecting employees' co-workers rather than defaulted employees' own accounts.

We have demonstrated that plan choice architecture clearly has a potent impact on target date use, but other factors correlated with the outcomes are also worth mentioning (for details see Appendix Table 2). Target-date adoption was highest among low-balance participants, falling for those with higher balances. Younger participants (under age 35) were also more likely to adopt TDFs, either as pure or mixed investors, even after controlling for effects of new hire auto enrollment. This suggests that, earlier in their life cycles, workers were either less financially sophisticated or more willing to adopt novel strategies or technologies; hence they were more attracted to TDFs even aside from default effects. We also note that target-date portfolio choice decisions did not change significantly during the 2008–09 financial crisis, indicating that the sharp decline in stock prices during the financial crisis did not alter participant demand.

Portfolio effects from adoption of target-date funds

Having examined how plan architecture influenced retirement savers' portfolios, we next assess how the arrival of TDFs in the fund menu shaped adopters' portfolio risk and return characteristics. To this end, we compare pure and mixed TDF investors with their non-TDF counterparts in terms of equity

[26]Evidence of an 'endorsement effect' resulting from an employer' designation of employer stock as the default for matching contributions was provided by Benartzi (2001), Brown et al. (2007), and Choi et al. (2004a).

shares, portfolio return and risk, Sharpe ratios, and nonsystematic or idiosyncratic portfolio risk or variance (reported as a share of the total variance, or NSR/TV). We further compare factor risk exposures of each participant subgroup.

As with adoption behavior, we measure several aspects of participants' portfolio allocations 1 year after the first appearance of TDFs in the plan menu. Equity allocations refer to the fraction of participants' portfolios held in equities in that month,[27] and risk and return characteristics are estimated using a six-factor asset pricing model over the prior 60 months drawing on monthly returns data for plan menu investments over a 17.5 year period (including the 150 month period under analysis, and the preceding 5 years). For example, if TDFs first appeared in a plan in September 2005, savers' equity allocations were observed a year later, in September 2006, and risk and return characteristics were estimated for the 60 months preceding and then predicted for September 2006. Factor returns were calculated using six factors: the market, size, value, and momentum factors for equities, and term and default factors for bonds.[28] All returns are net of all investment management fees.[29]

We note that over the analysis period of January 1998 through June 2015, the mean market factor return (the return of the equity market less the risk-free rate) was 5.95%, with a standard deviation of 16.1% over the period, while the mean term premium for bonds (the return of long-dated government bonds less the risk-free rate) was 5.41%, with a standard deviation of 10.5%. In other words, over our time period, the risk premium from equities over long-dated government bonds was small, and long-dated government bonds had a superior Sharpe ratio to equities. Our results should be interpreted in light of how future return and risk characteristics might resemble, or deviate from, these historical data.

Figure 1 summarizes equity share by age for four categories of investors: pure, mixed, non-target-date investors, and all participants. Most notable is the higher equity allocation at virtually all ages for pure and mixed target-date investors versus non-target-date investors. In addition, pure and mixed investors followed a distinctive age-based gradient or glidepath, whereas variation in equity share among non-target-date investors was hump-shaped in age.

Table 4 summarizes portfolio characteristics for our three groups of interest and the entire sample. Panel A shows the allocation of total contributions (employer and employee) by major asset class, including cash or principal-guaranteed funds (including money market and guaranteed investment contract funds), bonds, balanced or TDFs (including traditional balanced funds and static allocation or risk-based funds), U.S. equity funds, international equity funds, and employer stock. Panel B indicates equity shares, monthly systematic returns, and portfolio risk, Sharpe ratios, and nonsystematic risk.[30] Panel C summarizes portfolio risk exposures.

Contribution allocations in Panel A indicate that non-target-date investors held 22.3% of their portfolios in cash (i.e., money market instruments and guaranteed investment contracts), while Panel B shows they held an average of 63% in equities. By contrast, TDF investors invested substantially more equity: 80.8% for pure investors, and 76.1% for mixed investors. This difference produces

[27]Equity share is the percentage of employer and employee contributions directed to U.S. and international equity funds, company stock, and a percentage of balanced and TDFs. The equity percentage for balanced and TDFs was calculated based on each fund's holdings; it varies from fund to fund.

[28]To calculate portfolio returns over a given 60-month period, we construct a risk-loading matrix for all k investment options in a given plan by regressing the excess return (over Treasury bill returns) for each of the k assets on the six factors. The factor return for each 401(k) investment option in the predicted month is simply its factor exposure in that month times the average factor returns over the prior 60-month period; the participant's factor return is simply the weighted average return of his or her factor exposures over the period.

[29]Return calculations do not include the effect of recordkeeping fees (e.g., per capita fees such as $10 per quarter), which are charged by some plans and are assessed regardless of the assets in the account.

[30]Specifically, $NSR/TV_{i,t} = \hat{\Sigma}_i^{idio}/\hat{\Sigma}_i$. We estimate the variance-covariance matrix for all assets $\hat{\Sigma}$, which in turn is used to estimate the total portfolio variance for the ith participant, $\hat{\Sigma}_i$. $\hat{\Sigma} = \hat{B}'\hat{\Sigma}_f\hat{B} + \hat{D}$, where $\hat{D}$is a diagonal matrix with elements computed as the square of the $\hat{\varepsilon}_k$ estimated in equation (2). The asset variance can be decomposed into systematic risk, $\hat{\Sigma}^{sys} = \hat{B}'\hat{\Sigma}_f\hat{B}$ and idiosyncratic risk $\hat{D}^{idio}$. Individual portfolio variance is then decomposed into its systematic and idiosyncratic components: $\hat{\Sigma}_i = \omega'_{i,k,t}\hat{\Sigma}\omega_{i,k,t} = \omega'_{i,k,t}(\hat{\Sigma}^{sys} + \hat{D}^{idio})\omega_{i,k,t} = \hat{\Sigma}_i^{sys} + \hat{\Sigma}_i^{idio}$.

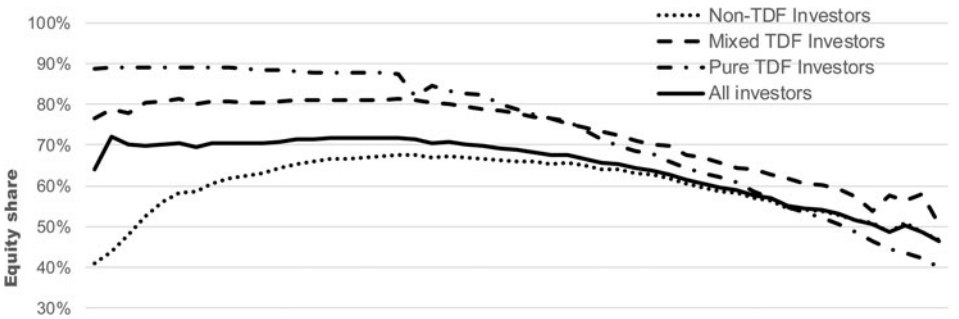

Figure 1. Equity share by age and investor type. *Source*: Authors' calculations.

higher market risk exposures in Panel C: 61.6% for non-target-date investors, 68.9% for pure, and 71% for mixed investors. Panel B also indicates that, before controlling on other observables, TDF portfolios yielded higher monthly systematic returns (60–70 basis points versus 36 basis points for non-TDF investors), slightly higher monthly volatility (2.8–3.1% versus 2.7%), lower monthly Sharpe ratios (13.1–15.5 versus 16.7), and substantially lower idiosyncratic or uncompensated risk (3.6–12.1% versus 25.3%). The most notable result in Panel C, besides the market risk increase already reported, is the sharply higher bond market term and default premia, particularly for pure investors, where these exposures doubled (e.g., for the default premium, 0.201 for pure investors versus 0.096 for non-target-date investors).

We also seek to determine how these portfolio metrics vary when controlling for observable differences in plan choice architecture and participant characteristics. Accordingly, we estimate a multivariate model of the following form:

$$PORTFOLIO_{i,j,t} = \alpha INVESTORS_{i,t} + \beta PLAN_{j,t} + \gamma PARTICIPANT_{i,t} + \nu_j + \tau_t + w_j + \varepsilon_{i,j,t} \qquad (2)$$

where $PORTFOLIO_{i,j,t}$ is a vector of the five outcome measures of interest – equity share, return and risk, nonsystematic risk and Sharpe ratio – and *INVESTORS* is a matrix representing the type of TDF investor (pure or mixed, reference non-target-date) and type of employee (new entrant, reference existing employee). *PLAN* and *PARTICIPANT* characteristics are also included as above in equation (1).[31]

Table 5 presents marginal effects for equity share, where Model 1 is as in equation (2), and Model 2 adds age interactions with target-date behavior. Results in Model 1 indicate that, on average, pure TDF adopters held 24 percentage points more equity compared to non-target-date investors, while mixed target-date investors held 13 percentage points more. Model 2 indicates that young pure investors (those under age 35) had an equity share averaging 34% points above the reference category, while older pure investors (those over age 55) had an equity share 7 percentage points higher; this implies an increase in the difference of 26 points. This result demonstrates a fundamental feature of TDFs, namely their intentional age gradient. For example, for non-target-date investors, the equity share

[31]As in equation (1), our models also control for plan-level heteroskedasticity (ν_j) by clustering errors at the plan level, time fixed effects (τ_t), and industry fixed effects, along with missing data dummies. All models also include a financial crisis control.

Table 4. Contribution allocations and portfolio characteristics of participants in plans adopting target-date funds

A. Contribution allocations (%)	Cash	Bonds	Balanced/ TDF	U.S. equities	International equities	Company stock
All investors	17.3	6.4	29.6	34.3	6.6	5.7
Non TDF investors	22.3	7.7	13.7	41.9	7.7	6.8
Pure TDF investors	0.0	0.0	100.0	0.0	0.0	0.0
Mixed TDF investors	5.9	7.2	39.9	31.1	9.3	6.5

B. Portfolio characteristics (%)			Six-factor CAPM, predicted		
	Equity share	Monthly returns	Monthly risk (σ)	Sharpe ratio	NSR/TV
All investors	67.0	0.44	2.75	16.2	20.7
Non TDF investors	63.0	0.36	2.71	16.7	25.3
Pure TDF investors	80.8	0.70	2.77	15.5	3.6
Mixed TDF investors	76.1	0.60	3.07	13.1	12.1

C. Portfolio risk exposures							
	β(Mkt)	β(SMB)	β(HML)	β(UMD)	β(Default)	β(Term)	β(RMSE)
All investors	0.636	−0.011	0.084	−0.008	0.117	0.080	0.010
New entrants	0.621	−0.024	0.086	−0.002	0.150	0.099	0.008
Existing employees	0.640	−0.008	0.083	−0.010	0.109	0.075	0.010
Non TDF investors	0.616	0.001	0.079	−0.011	0.096	0.065	0.010
Pure TDF investors	0.689	−0.073	0.099	0.005	0.201	0.138	0.007
Mixed TDF investors	0.710	−0.006	0.093	−0.005	0.151	0.103	0.011

Note: The following β differences are significant at the 1% level: new entrants versus existing employees; pure versus mixed investors; pure versus non-TDF; and mixed versus non-TDF investors.
Source: Authors' computations using Vanguard data; see text and Appendix Table 3 for variable definitions.

Table 5. Marginal effects of equity share and target date treatment

	Mean	Equity share (1)	Equity share (2)
TDF investors (%)			
Pure TDF investors	15.7	0.240**	0.212**
Mixed TDF investors	9.0	0.126**	0.116**
Young*pure TDF investors (%)	6.5		0.125**
Old*pure TDF investors (%)	1.5		−0.139**
Young*mixed TDF investors (%)	2.6		0.062**
Old*mixed TDF investors (%)	1.1		−0.043**
Choice architecture			
New-hire auto enrollment (%)	32.9	−0.017	−0.018
New entrants	19.7	−0.016	−0.022
Participant characteristics			
Log balance (mean 2015$)	9.9	0.024**	0.024**
Job tenure (years)	10.0	−0.002**	−0.002**
Young (% <35)	25.1	0.046**	0.010*
Old (% >55)	15.2	−0.117**	−0.100**
Male (%)	69.4	0.032**	0.032**
HH income low (% <$62.5 K)	31.0	−0.026**	−0.027**
HH income high (%>$87.5 K)	42.3	0.015**	0.015**
Wealth low (%<$7.3 K)	17.9	−0.028**	−0.029**
Wealth high (%>$61.2 K)	49.9	0.025**	0.024**
Financial crisis (% months)	8.1	−0.012	−0.010
Intercept		0.445**	0.458**
Controls		Yes	
Observations		1,262,506	
Number of clusters (plans)		880	
R^2		0.151	0.158
Mean of dependent variable		67.0%	67.0%

Note: Equity share refers to the percentage of participant contributions directed to stock market investments. Controls include plan-level indicators of the number of funds, employer stock, and loans offered. Standard errors clustered at the plan level. *Significant at 5%, ***significant at 1%.
Source: Authors' computations using Vanguard data; see text and Appendix Table 3 for variable definitions.

was 1 point higher for young investors and 10 points lower among the older age group, a difference of only 11 points.

Table 6 presents estimated marginal effects for other portfolio characteristics of interest. Monthly factor returns for pure TDF investors were 19 basis points per month higher (equivalent to 2.3% on an annualized basis), while mixed investors were 14 basis points per month higher (1.7% annualized). These are sizeable increases relative to the mean factor return of 44 basis points per month in our dataset (5.4% annualized). Given their higher equity allocations, it is also not surprising that pure (mixed) target-date investors experienced larger portfolio standard deviations by 32 (29) basis points. Also of interest is that predicted Sharpe ratios were statistically insignificantly different for target-date investors compared to non-target-date investors. This suggests that target-date adoption moved participants up the efficient frontier compared to non-target-date investors, in that they were exposed to more equity, higher expected returns, and more risk. Yet, non-target-date investors – who principally owned diversified mutual fund portfolios and cash equivalents, as noted in Table 4 – were also on the efficient frontier but at a lower risk/return point.[32]

One other remarkable lesson from Table 6 is the impact of TDFs on nonsystematic risk as a percentage of the total variance. Idiosyncratic risk overall was around 21% of the total variance across the entire sample. For pure investors, the diversifiable risk was essentially eliminated, with an estimated marginal reduction of 27 percentage points; for mixed investors, it was substantially lower, by 13 percentage points. These results reflect the index nature of the TDFs offered to sample participants.

[32]80% of the assets of all investors were held in low-cost Vanguard mutual funds and trusts, including both active and passive strategies, and the remainder in a range of non-Vanguard funds or trusts.

Table 6. Marginal effects of portfolio outcomes and target date treatment

	Mean	Monthly Return	Monthly risk (σ)	Sharpe ratio	NSR/TV
TDF investors (%)					
Pure TDF investors	15.7	0.0019*	0.0032**	−0.0687	−0.2703**
Mixed TDF investors	9.0	0.0014*	0.0029**	−0.0348	−0.1344**
Choice architecture					
New-hire auto enrollment (%)	32.9	−0.0014	−0.0010	−0.0722	0.0051
New entrants	19.7	−0.0006	−0.0012**	−0.0209	0.0225
Participant characteristics					
Log balance (mean 2015$)	9.9	0.0004	0.0008**	−0.0015	−0.0165**
Job tenure (years)	10.0	0.0000	−0.0001**	0.0022**	0.0015**
Young (% <35)	25.1	0.0002	0.0013**	−0.0079	−0.0019
Old (% >55)	15.2	−0.0006	−0.0041**	0.0401**	0.0440**
Male (%)	69.4	0.0003	0.0013**	0.0089	−0.0033
HH income low (% <$62.5 K)	31.0	−0.0004**	−0.0011**	0.0028	0.0182**
HH income high (%>$87.5 K)	42.3	−0.0001	0.0005**	−0.0111*	−0.0080**
Wealth low (%<$7.3 K)	17.9	0.0001	−0.0009**	0.0250*	0.0224**
Wealth high (%>$61.2 K)	49.9	−0.0002	0.0009**	−0.0182**	−0.0148**
Financial crisis (% months)	8.1	−0.0528**	0.0006	−1.3855**	0.0385*
Intercept		0.0320**	0.0286**	1.0203**	0.3548**
Controls			Yes		
Observations			1,262,506		
Number of clusters (plans)			880		
R^2		0.514	0.247	0.447	0.179
Mean of dependent variable		0.0044	0.0275	0.1621	0.2069

Note: See text for the definition of dependent variables. Controls include plan-level indicators for the number of funds, employer stock, and loans offered. Standard errors clustered at the plan level. *Significant at 5%, **significant at 1%.
Source: Authors' computations using Vanguard data; see text and Appendix Table 3 for variable definitions.

Finally, Table 7 compares factor risk exposures across types of participants. Given that plan investment menus were dominated by diversified equity funds prior to the arrival of TDFs, mean market exposure was already 64%. Pure (mixed) target-date adoption raised this further, by 14 (9) percentage points. The second most sizeable equity factor was value (high minus low [HML]), at 8%, and both the pure and mixed target-date options raised the value exposure of adopters materially, relative to that 8%. Another striking difference was the increase in exposure to bonds among target-date versus non-target-date investors. For example, pure investors had nearly double the exposure to the default factor (10 percentage point increase on a mean of 12%) and the term premium (7 point increase on a mean of 8%), and similar-sized effects are relevant to the term factor. Accordingly, TDFs extended participants out the yield curve and boosted their exposure to corporate debt, while reducing their cash holdings.[33]

These changes reflect an important development in 401(k) portfolio plans: adopters shift from a model of own-portfolio choice to a model of portfolio choice overseen by the TDF manage and the employer. To illustrate the potential benefits of target-date adoption, a hypothetical 30-year-old participant earning $35,000 per year and saving 10% of wages would generate retirement wealth of nearly $300,000 over a 30-year period, assuming the mean excess return of 5.4% experienced in our data. That retirement nest egg would be 50% higher for pure investors and one third higher for mixed investors at the end of that same period, assuming the use of a low-cost, widely diversified target-date series as in our sample.[34]

These are potentially substantial effects from target-date adoption by participants. We cannot attribute these results solely as the causal treatment effect of TDFs because of employer and participant

[33]This is consistent with anecdotal observations about inexperienced investors and their relative lack of understanding of, and exposure to, the bond market (a bond market participation problem).

[34]We use the mean return changes for pure and mixed target-date investors, respectively 2.4% and 1.7% annualized, from Table 5. We assume 1% real wage growth, and importantly no leakage from retirement accounts over the period. The calculations assume an end-of-period convention, and they are available from the authors.

Table 7. Marginal effects of portfolio risk exposures and target date treatment

	Mean	β(Mkt)	β(SMB)	β(HML)	β(UMD)	β(Default)	β(Term)	β(RMSE)
TDF investors (%)								
Pure TDF investors	15.7	0.135**	−0.084**	0.026**	0.012**	0.101**	0.072**	−0.002**
Mixed TDF investors	9.0	0.090**	−0.015**	0.013**	0.004**	0.050**	0.040**	0.001*
Choice architecture								
New-hire auto enrollment (%)	32.9	−0.018	−0.002	−0.011*	0.002	−0.008	−0.005	−0.001*
New entrants	19.7	−0.015	0.014**	0.000	0.003**	0.001	−0.003	0.000
Participant characteristics								
Log balance (mean 2015$)	9.9	0.022**	0.003**	0.002**	0.000	0.002**	0.000	0.000**
Job tenure (years)	10.0	−0.002**	−0.001**	0.000	0.000*	−0.001**	−0.001**	0.000*
Young (% <35)	25.1	0.032**	0.005**	0.011**	0.003**	0.011**	−0.007**	0.001**
Old (% >55)	15.2	−0.100**	−0.009**	−0.013**	−0.001**	−0.010**	0.012**	−0.001**
Male (%)	69.4	0.028**	0.006**	0.001	0.000	0.002	−0.004**	0.001**
HH income low (% <$62.5 K)	31.0	−0.026**	−0.003**	−0.003**	0.000	−0.003**	−0.001*	0.000**
HH income high (%>$87.5 K)	42.3	0.015**	0.004**	0.002**	0.000	0.002**	0.001	0.000**
Wealth low (%<$7.3 K)	17.9	−0.028**	−0.002**	−0.001	0.000	−0.003*	−0.001*	0.000**
Wealth high (%>$61.2 K)	49.9	0.024**	0.003**	0.000	0.000	0.001	0.000	0.000**
Financial crisis (% months)	8.1	−0.004	−0.005	0.013	0.003	0.003	0.004	0.001
Intercept		0.451**	−0.048**	0.065**	−0.022**	0.027*	0.053**	0.007**
Controls				Yes				
Observations				1,262,506				
Number of clusters (plans)							880	
R^2		0.111	0.140	0.098	0.111	0.247	0.151	0.151
Mean of dependent variable		0.636	−0.011	0.084	−0.008	0.117	0.080	0.010

Note: See text for definition of dependent variables. Controls include plan-level indicators for number of funds, employer stock, and loans offered. Standard errors clustered at the plan level. *Significant at 5%, **significant at 1%.
Source: Authors' computations using Vanguard data; see text and Appendix Table 3 for variable definitions.

self-selection. As noted at the outset, some employers may have introduced the funds or designated them as defaults under automatic enrollment because they felt that participants needed remedial portfolio help – for example, they held too much cash, invested too little in bonds, were under-diversified, and or failed to rebalance with age. In voluntary enrollment settings, participants might have selected the TDFs due to the retirement-date labeling, which acts as an implicit advice feature, or the convenience of the age-based rebalancing.

Nonetheless, among adopters, TDFs are clearly associated with sizeable shifts in portfolio risk factors and potential increases in future retirement wealth, relative to non-target-date investors. These are benefits adopters could have realized on their own at any time – but they did not take place until the arrival of TDFs in the plan menu. [35] Moreover, beyond these results signal that the provision of scalable low-cost advice can have important consequences for nonprofessional investors in domains other than 401(k) plans – in terms of risk-taking and portfolio diversification.

Conclusions and discussion

Portfolio choice in U.S. defined contribution plans is gradually shifting from an own-portfolio choice model to a regime where participant portfolio choice is delegated to a TDF manager selected by the employer. Our paper illustrates how the introduction of TDFs, either in voluntary choice or automatic enrollment plans, has led to this fundamental change. We examine 880 retirement plans covering 1.2 million participants to demonstrate the importance of key behavioral mechanisms in target-date adoption, and in turn, how TDF adoption resulted in a substantive change in portfolio risk factors among adopters.

We identify three distinct behavioral effects influencing adoption when TDFs were introduced in voluntary or automatic enrollment environments. One is an active choice effect: in voluntary

[35]Tang et al. (2010) show that virtually all employees could have 'rolled their own' portfolios to mimic the age-relevant TDF mix using funds available prior to the inclusion of the TDFs on the menu.

enrollment plans, 28.4% of new entrants adopted TDFs in their 401(k) portfolios, compared to only 10.2% of existing employees. A second is a substantial default effect: 78.7% of new entrants in plans with new-hire automatic enrollment adopted TDFs, versus 28.4% in voluntary plans. Third is a default-related endorsement effect: in new-hire automatic enrollment plans, 21.7% of existing employees not subject to auto-enrollment invested in the funds, double the rate of existing employees in voluntary choice plans. Similar effects play out in terms of pure versus mixed target-date investors.

Our second set of findings relates to portfolio outcomes. Target-date adoption leads to a sizeable change in portfolio risk-taking. For example, pure investors adopting a single fund had a higher equity share (+24 percentage points), a sharper age equity share gradient (+26 points), and higher factor returns (+2.3% annualized), versus non-target-date holders. Besides boosting equity shares for pure and mixed investors, TDFs also produced a distinctive age-based gradient in risk-taking, compared to a hump-shaped equity allocation among non-target-date investors. As our factor analysis shows, target-date participants took on the factor exposures embedded in the target-date series offered by the fund manager and selected by the employer. In our sample of indexed, broadly diversified TDFs, that meant greater market risk exposure, higher exposures to term and default premia, and reduced risk.[36]

In other words, target-date investors take greater risks across the lifecycle, follow a lifecycle-based age gradient, and enhance their exposure to factors embedded in the funds designed by the portfolio manager. These changes could be welfare-enhancing under the joint assumptions that the target-date design represents an efficient portfolio frontier (selected by the sponsor and fund manager), and that workers without TDFs would fail to construct efficient portfolios, or would choose suboptimal points on that frontier, due to either investment literacy problems or behavioral biases. One illustration of the potential welfare benefits is the potential impact of higher equity exposure on long-term retirement wealth accumulation. We estimate that pure target-date investors in a low-cost broadly diversified target-date series might realize retirement wealth that is up to 50% higher relative to non-target-date investors. For mixed investors, it is up to 30%. We recognize, of course, that target-date adopters are taking more risk, particularly at younger ages. Whether this proves to be welfare-enhancing will ultimately depend on a specification of investors' utility functions over the lifecycle, an exercise which is beyond the scope of this paper.

If these are reasonable estimates of potential benefits, a related question is whether plan sponsors and policymakers could increase target-date adoption among existing 401(k) participants. One approach might be to use 'reenrollment,' whereby U.S. plan sponsors could transfer existing employees' investments into age-specific TDFs (or any other default fund), with advance notification to the employee and with the right of the employee to opt out of the move. In view of our results, reenrollment could lead to similar changes as outlined here for existing non-target-date investors.[37]

Finally, our results point to the potential effects of providing low-cost, scalable investment advice more broadly. TDFs differ from other balanced funds since they tailor their recommendations based on a single factor, age. Similar to TDFs, low-cost lifecycle investment algorithms incorporating age and other personal characteristics might also help reduce portfolio construction deficiencies in other settings, such as retail investment accounts or personal pensions. This is particularly important given our evidence that there is a sharp divergence between portfolio construction decisions made by nonprofessional investors such as 401(k) investors versus advice provided by professional advisers. Mechanisms like low-fee TDFs or robo-advice services[38] have the potential to reduce this 'advice gap' and improve outcomes for other groups of nonprofessional investors, including potentially reducing the heterogeneity of returns across households or addressing biases in traditional professional advice.[39]

[36]A similar result is reported by Keim and Mitchell (2018) who analyzed TDF introduction at a single firm.
[37]For more on reenrollment, see Pagliaro and Utkus (2016, 2017b).
[38]See Agnew and Mitchell (2019) and Rossi and Utkus (2020).
[39]See Campbell et al. (2019) and Inderst and Ottaviani (2012).

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References

Agnew J and Mitchell OS (eds) (2019) *The Disruptive Impact of FinTech on Retirement Systems*. Oxford, UK: Oxford University Press.

Agnew J and Szykman L (2005) Asset allocation and information overload: the influence of information display, asset choice and investor experience. *Journal of Behavioral Finance* **6**(2), 57–70.

Agnew J, Balduzzi P and Sunden A (2003) Portfolio choice and trading in a large 401(k) plan. *American Economic Review* **93**(1), 193–215.

Agnew J, Szykman L, Utkus SP and Young JA (2012) Target Date Funds: Survey and Administrative Evidence. Working Paper. Available at https://www.aeaweb.org/conference/2013/retrieve.php?pdfid=460.

Ameriks J and Zeldes S (2001) How Do Household Portfolio Shares Vary with Age? TIAA-CREF Institute Working Paper 6–120101.

Ameriks J, Hamilton DJ and Ren L (2011) *Investor Comprehension and Usage of Target Date Funds: 2010 Survey*. Malvern, PA: Vanguard Investment Counseling and Research.

Balduzzi P and Reuter J (2019) Heterogeneity in target date funds: strategic risk-taking or risk matching? *Review of Financial Studies* **32**(1), 300–337.

Barber BM and Odean T (2001) Boys will be boys: Gender, overconfidence, and common stock investment. *The Quarterly Journal of Economics* **116**, 261–292.

Basu AK, Byrne A and Drew ME (2011) Dynamic lifecycle strategies for target date retirement funds. *Journal of Portfolio Management. Winter* **37**(2), 83–96.

Bekaert G, Hoyem K, Hu W-Y and Ravina E (2017) Who is internationally diversified? Evidence from the 401(k) plans of 296 firms. *Journal of Financial Economics* **124**(1), 86–112.

Benartzi S (2001) Excessive extrapolation and the allocation of 401(k) accounts to company stock. *Journal of Finance* **56**(5), 1747–1764.

Benartzi S and Thaler RH (2001) Naïve diversification strategies in defined contribution savings plans. *American Economic Review* **91**(1), 79–98.

Benartzi S and Thaler RH (2002) How much is investor autonomy worth? *Journal of Finance* **57**(4), 1593–1616.

Benartzi S, Peleg E and Thaler RH (2007) Choice Architecture and Retirement Savings Plans. SSRN Working Paper. July.

Beshears J, Choi JJ, Laibson D and Madrian BC (2018) Behavioral household finance. In Bernheim BD, DellaVigna S and Laibson D (eds), *Handbook of Behavioral Economics: Foundations and Applications 1*. Amsterdam: Elsevier, pp. 177–276.

Brown DC and Davies S (2020) Off Target: On the Underperformance of Target-Date Funds. Available at https://ssrn.com/abstract=3707755.

Brown JR, Lang N and Weisbenner S (2007) Individual account investment options and portfolio choice: behavioral lessons from 401(k) plans. *Journal of Public Economics* **91**(10), 1992–2013.

Calvet LE, Campbell JY and Sodini P (2009) Fight or flight? Portfolio rebalancing by individual investors. *Quarterly Journal of Economics* **124**, 301–348.

Campbell J and Viceira L (2002) *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*. New York: Oxford University Press.

Campbell J, Ramadorai T and Ranish B (2019) Do the rich get richer in the stock market? Evidence from India. *AER: Insights* **1**(2), 225–240.

Carroll GD, Choi JJ, Laibson D, Madrian BC and Metrick A (2009) Optimal defaults and active decisions. *Quarterly Journal of Economics* **124**(4), 1639–1674.

Choi JJ, Laibson D, Madrian BC and Metrick A (2003) Optimal defaults. *American Economic Review* **93**(2), 180–185.

Choi JJ, Laibson D and Madrian BC (2004a) Plan design and 401(k) savings outcomes. *National Tax Journal* **57**(2), 275–298.

Choi JJ, Laibson D, Madrian B and Metrick A (2004b) For better or for worse: Default effects and 401(k) savings behavior. In Wise ED (ed.), *Perspectives in the Economics of Aging*. Chicago: University of Chicago Press, pp. 81–121.

Choi JJ, Laibson D, Madrian BC and Metrick A (2006) Saving for retirement on the path of least resistance. In McCaffrey E and Slemrod J (eds), *Behavioral Public Finance: Toward A New Agenda*. New York: Russell Sage Foundation, pp. 304–351.
Clark JW and Young JA (2018) *Automatic Enrollment: The Power of the Default*. Vanguard Center for Investor Research. Valley Forge: The Vanguard Group.
Cocco J, Gomes F and Maenhout P (2005) Consumption and portfolio choice over the life cycle. *Review of Financial Studies* **18**, 401–533.
Elton EJ, Gruber MJ and Blake CR (2007) Participant reaction and the performance of funds offered by 401(k) plans. *Journal of Financial Intermediation* **16**, 249–271.
Goda G, Levy MR, Manchester CF, Sojourner A and Tasoff J (2020) Who is a passive saver under opt-in and auto-enrollment? *Journal of Economic Behavior & Organization* **173**, 301–321.
Huberman G and Jiang W (2006) Offering vs. choices in 401(k) plans: equity exposure and number of funds. *Journal of Finance* **41**(2), 763–801.
ICI (2019) *Release: Quarterly Retirement Market Data, First Quarter* 2019. Washington, DC: Investment Company Institute. https://www.ici.org/research/stats/retirement.
Inderst R and Ottaviani M (2012) How (not) to pay for advice: a framework for consumer financial protection. *Journal of Financial Economics* **105**(2), 393–411.
Iyengar S and Kamenica E (2010) Choice proliferation, simplicity seeking, and asset allocation. *Journal of Public Economics* **94**(7–8), 530–539.
Iyengar S, Huberman G and Jiang W (2004) How much choice is too much? Contributions to 401(k) retirement plans. In Mitchell OS and Utkus SP (eds), *Pension Design and Structure: New Lessons From Behavioral Finance*. Oxford: Oxford University Press, pp. 83–96.
Keim DB and Mitchell OS (2018) Simplifying choices in defined contribution retirement plan design. *Journal of Pension Economics and Finance* **17**(3), 363–384.
Lusardi A and Mitchell OS (2007) Baby boomer retirement security: the role of planning, financial literacy, and housing wealth. *Journal of Monetary Economics* **54**(1), 205–224.
Lusardi A and Mitchell OS (2011) Financial literacy and retirement planning in the United States. *Journal of Pension Economics & Finance* **10**(4), 509–525.
Lusardi A and Mitchell OS (2014) The economic importance of financial literacy: theory and evidence. *Journal of Economic Literature* **52**(1), 5–44.
Madrian B and Shea DF (2001) The power of suggestion: inertia in 401(k) participation and savings behavior. *Quarterly Journal of Economics* **116**(4), 1149–1525.
Massa M, Moussawi R and Simonov A (2020) The unintended consequences of investing for the long run: Evidence from target date funds. Available at https://ssrn.com/abstract=3729750.
McDonald RL, Richardson DP and Rietz TA (2019) The effect of default target date funds on retirement savings allocations. TIAA Institute Working Paper.
Mitchell OS and Lusardi A eds (2011) *Financial Literacy: Implications for Retirement Security and the Financial Marketplace*. Oxford: Oxford University Press.
Mitchell OS, Mottola GR, Utkus SP and Yamaguchi T (2006a) The inattentive participant: Portfolio trading behavior in 401 (k) plans. Pension Research Council Working Paper 2006–05. Philadelphia, PA.: Wharton School.
Mitchell OS, Mottola GR, Utkus SP and Yamaguchi T (2006b) Winners and losers: 401(k) trading and portfolio performance. Pension Research Council Working Paper 2006–26. Philadelphia, PA.: Wharton School.
Morningstar (2021) *2021 Target-Date Strategy Landscape*. Chicago, IL: Morningstar, Inc. Available at https://www.morningstar.com/lp/tdf-landscape.
Mottola GR and Utkus SP (2008) Red, yellow, and green: Measuring the quality of 401(k) portfolio choices. In Aaron H (ed.), *Overcoming the Savings Slump: How to Increase the Effectiveness of Financial Education and Saving Programs*. Chicago: University of Chicago Press, pp. 199–139.
O'Donoghue T and Rabin M (1999) Procrastination in preparing for retirement. In Aaron H (ed.), *Behavioral Dimensions of Retirement Economics*. Washington, DC: Brookings Institution Press and Russell Sage Foundation, pp. 125–156.
O'Donoghue T and Rabin M (2001) Choice and procrastination. *Quarterly Journal of Economics* **116**(1), 121–160.
OECD (2015) *The OECD Roadmap for the Good Design of Defined Contribution Pension Plans*. Available at http://www.oecd.org/finance/private-pensions/50582753.pdf
Pagliaro CA and Utkus SP (2016) *Reshaping Participant Outcomes Through Reenrollment*. Vanguard Center for Investor Research. Valley Forge: The Vanguard Group.
Pagliaro CA and Utkus SP (2017a) *A Different Kind of Target Date Investor*. Vanguard Center for Investor Research. Valley Forge: The Vanguard Group.
Pagliaro CA and Utkus SP (2017b) *Reenrollment: One Year Later*. Vanguard Center for Investor Research. Valley Forge: The Vanguard Group.
Parker JA, Schoar A and Sun Y (2020) Retail financial innovation and stock market dynamics: The case of target date funds. NBER Working Paper No. 8028. National Bureau of Economic Research, Cambridge, MA.

Pool VK, Sialm C and Stefanescu I (2016) It pays to set the menu: mutual fund investment options in 401(k) plans. *Journal of Finance* **71**(4), 1779–1812.

Rossi AG and Utkus SP (2020) Who benefits from robo-advising? Evidence from machine learning. Available at https://ssrn.com/abstract=3552671.

Shoven JB and Walton DB (2020) An analysis of the performance of target date funds. NBER Working Paper No. 27971 National Bureau of Economic Research, Cambridge, MA.

Tang N, Mitchell OS, Mottola GR and Utkus SP (2010) The efficiency of sponsor and participant portfolio choices in 401 (k) plans. *Journal of Public Economics* **94**(11–12), 1073–1085.

Thaler R and Sunstein C (2008) *Nudge: Improving Decisions About Health, Wealth, and Happiness*. New Haven: Yale University Press.

Vanguard (2019) *How America Saves* 2019*: A Report on Vanguard* 2018 *Defined Contribution Plan Data*. Vanguard Center for Investor Research. Valley Forge: The Vanguard Group.

van Rooij M, Lusardi A and Alessie R (2011) Financial literacy and stock market participation. *Journal of Financial Economics* **101**(2), 449–472.

Viceira LM (2001) Optimal portfolio choice for long-horizon investors with nontradable labor income. *Journal of Finance* **56**, 433–470.

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