Working Paper

Asset Allocations and Risk-Return Tradeoffs of Target-Date Funds

Gaobo Pang and Mark Warshawsky [*]

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Abstract

This stochastic simulation analysis examines the characteristics of target-date funds with varied asset allocations, focusing on the trade-offs between wealth creation and security. The dynamic portfolio adjustment of target-date funds along age forms an improvement over the observed general investment behavior of individuals in retirement accounts. Nonetheless, the risk-return tradeoffs associated with equity exposure, particularly for workers approaching retirement, underscore the importance of full disclosure, realistic assessment of risk tolerance and participant behavior, and due consideration of income strategies at, and during, retirement.

Key words: target-date fund, asset allocation, retirement accounts

JEL classifications: G11, G23, D14, D81

Gaobo Pang
Watson Wyatt Worldwide
Gaobo.Pang@watsonwyatt.com

Mark Warshawsky
Watson Wyatt Worldwide
Mark.Warshawsky@watsonwyatt.com

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[*] Research and Innovation Center at Watson Wyatt Worldwide. Opinions expressed here are the authors' own and not necessarily those of their affiliation, and also do not constitute investment advice. We thank Susan Farris, Francis Grealy, Brian Hersey, David O'Meara, Michael Orszag, and Erica Wolf for useful comments and suggestions.

I. Introduction

Target-date funds (TDFs), also known as life-cycle funds, have gained popularity among 401(k) plan participants and other investors saving for retirement. Through adjusting the equity share by age, proxying for human capital (earnings) prospects, a TDF offers a simple way to combine stocks and fixed-income securities into a single dynamic fund. For most defined contribution (DC) plan sponsors and participants, however, questions remain about the appropriate entry portfolios, the speed and nature of portfolio adjustment along the life cycle, and exit strategies upon and during retirement. As has been evidenced by the current financial crisis, TDF investors may face significant investment losses, depending on the stock and bond market exposures.

The Pension Protection Act of 2006 created new safe harbors for employers to adopt certain automatic enrollment arrangements in DC plans, especially 401(k)s, for eligible employees. The Department of Labor's regulations on "qualified default investment alternatives (QDIAs)," which feature TDFs, essentially mandated holdings of equities rather than the money market and stable value funds that many plan sponsors had used in the past as default investments for their participants. The plan fiduciary is relieved of some liability when a qualified alternative is implemented if the plan participant fails to make investment elections. Because it is believed by some that the possibility of investment losses was not well communicated to plan participants in TDFs and that the actual losses in 2008 and 2009 have been particularly harmful to those approaching retirement, TDFs are now also attracting heightened legislative and regulatory attention.

This analysis examines, via stochastic simulation, the risk-return characteristics of TDFs actually marketed, with varied asset allocations, focusing on the trade-offs between wealth creation and security. We consider long-horizon investors who select or default into TDFs early in their career and also older workers who start utilizing TDFs just years before retirement. The stochastic simulation model produces probability distributions of final wealth balances of TDFs whose allocations fall in the spectrum of equity exposure, at various horizons. The model allocations are based on market data of equity-bond-cash allocations of tens of TDFs. For retirees, we further consider and compare income strategies such as systematic withdrawals and purchases of fixed payout life annuities from TDFs.

II. Asset Allocations in Target-Date Funds

A target-date fund holds a diversified mix of stocks, bonds and other assets. As the investor approaches retirement (the preset target date), the asset mix shifts away from stocks toward fixed-income securities. TDFs have mushroomed in recent years, with their assets increasing from $5.5 billion in 2000, to over $150 billion in 2007, and to over $204 billion by May 2008.[1]

Consideration for "human capital" lends support to the idea that the equity share of retirement wealth accumulations should generally start high and then decline with age.

[1] Poterba et al. (2006), TIAA-CREF (2007), and Young (2008).

Human capital, regarded as the present value of future wages, is thought to carry less risk than equity and is more comparable to a bond. For most risk tolerances, larger equity holdings at a younger age complement the large human capital bond, whereas smaller equity and larger fixed-income holdings at an older age complement the declining value of human capital.[2]

Empirical evidence seems to show that the individual portfolios of retirement accounts differ significantly from this theoretical optimum. Table 1 reports the equity allocations by age of household head, based on the 2007 Survey of Consumer Finances. For all age bands, a significant number of households place their portfolios at the extremes – either nothing or all in equity. Roughly one third of investors hold 75+ percent of their account balances in equity. There is no clear tendency that investors start with a high equity exposure in their 20' or 30's and shift to bonds when they get close to retirement. Inertia may play a part as plan participants rarely reallocate their account balances. The portfolio line-ups and the automatic asset reallocation of TDFs are intended to help these investors improve their wealth creation and management, particularly along the age dimension.

Table 1. Equity allocations in retirement accounts by age of workers

	Percentage of assets allocated to equity							% of
Age	0%	1-24%	25-49%	50-74%	75-99%	100%	All	sample
25-34	19.6	9.0	17.5	17.8	15.3	20.9	100.0	16.7
35-44	15.7	9.3	16.2	23.1	13.4	22.3	100.0	25.5
45-54	13.5	10.3	20.2	25.4	13.0	17.7	100.0	31.6
55-64	17.2	8.5	16.5	23.0	13.4	21.5	100.0	26.3
Total	16.0	9.4	17.8	22.9	13.6	20.4	100.0	100.0

Notes:
1. Retirement accounts include DC plans for current and prior jobs and all IRAs.
2. The sample includes heads and spouses if they have a positive account balance and at least one household member is working.

Source: Authors' calculations based on Survey of Consumer Finances 2007.

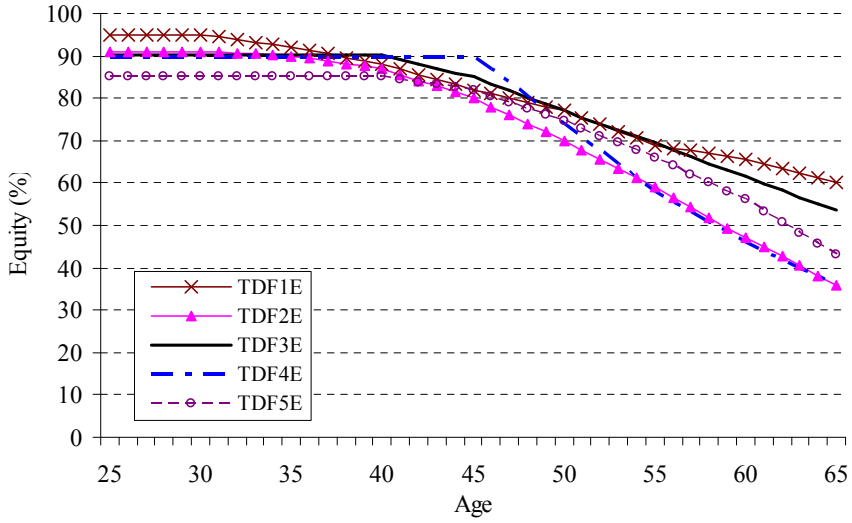
For most 401(k) plan sponsors and participants, however, questions remain about the appropriate entry portfolios, the speed and nature of portfolio adjustment along the life cycle, and exit positions upon retirement. In principle, the choices hinge on participants' risk preferences, the extent of any defined benefit pension and Social Security coverage, the stability of their earnings, liquidity needs, personal characteristics, and their planned retirement year. In practice, it is difficult to pinpoint these and other relevant factors and quantify them into a simple formula. In the marketplace, there is substantial variation in asset allocations among TDFs. When 401(k) plan participants select or default into different TDFs, their wealth profiles may differ significantly at retirement.

We first consider long-horizon investors who start utilizing TDFs in their early career. Figure 1 plots the glide paths of five TDFs, which are respectively at the 95th, 75th, 50th, 25th, and 5th percentiles, by equity share, of tens of 2050 TDFs on the market as of May 27, 2009. Because these TDFs are targeted for young workers who expect a long flow of bond-like labor earnings before retirement, all of them offer high equity position upon

[2] See discussions by Bodie et al. (1992) and Viceira et al. (2008), for instance.

entry, ranging from 85 percent to 95 percent. Over the investment horizon of 40 years, portfolios in these fund families, which we designate TDF1E through TDF5E, are being shifted to bonds and cash. The variation of ending equity positions is even greater, from 35 percent to 60 percent, and there are cross-overs in equity shares along the way for these fund families.

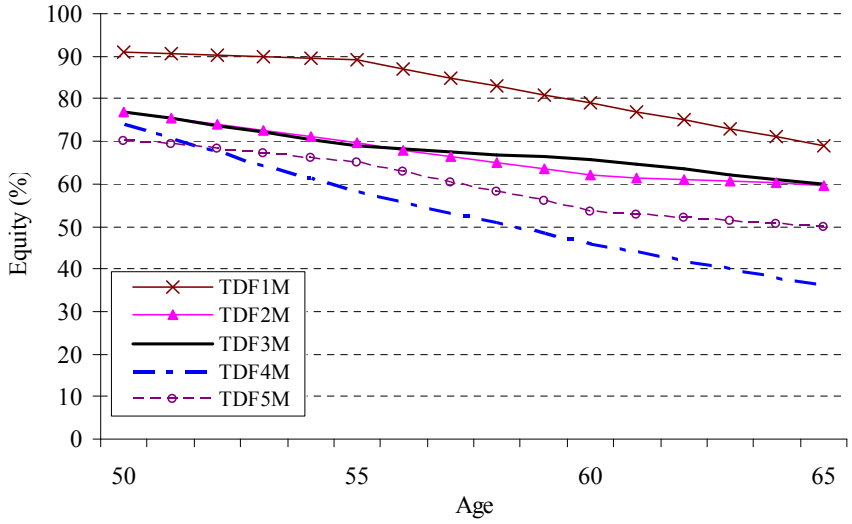
Figure 1. TDF Asset Allocations for Early-Career Workers



Notes: The percentiles of TDFs are identified by equity allocations in 2050 TDFs, with bond and cash allocations collected correspondingly. The glide paths are constructed by connecting all TDFs for each fund family. Allocations for ages between target dates are linearly interpolated.
Source: Authors' data collection from Morningstar and TDF providers' websites as of May 27, 2009.

Some workers may enter TDFs at the middle of their career. This situation may emerge, for example, when workers reallocate their investment portfolios within 401(k) plans or when workers re-invest their retirement plan wealth upon job change. Figure 2 plots five TDFs (spanning the same percentiles of equity exposure at the initial allocation) that are targeted to mid-career workers who are likely to retire in 15 years. These TDFs commonly place initially 70 to 80 percent of assets in equity, but TDF1M has over 90 percent of assets in equity. Workers following glide paths of these respective fund families will have 35 to 70 percent of their wealth in equity at retirement.

Figure 2. TDF Asset Allocations for Mid-Career Workers



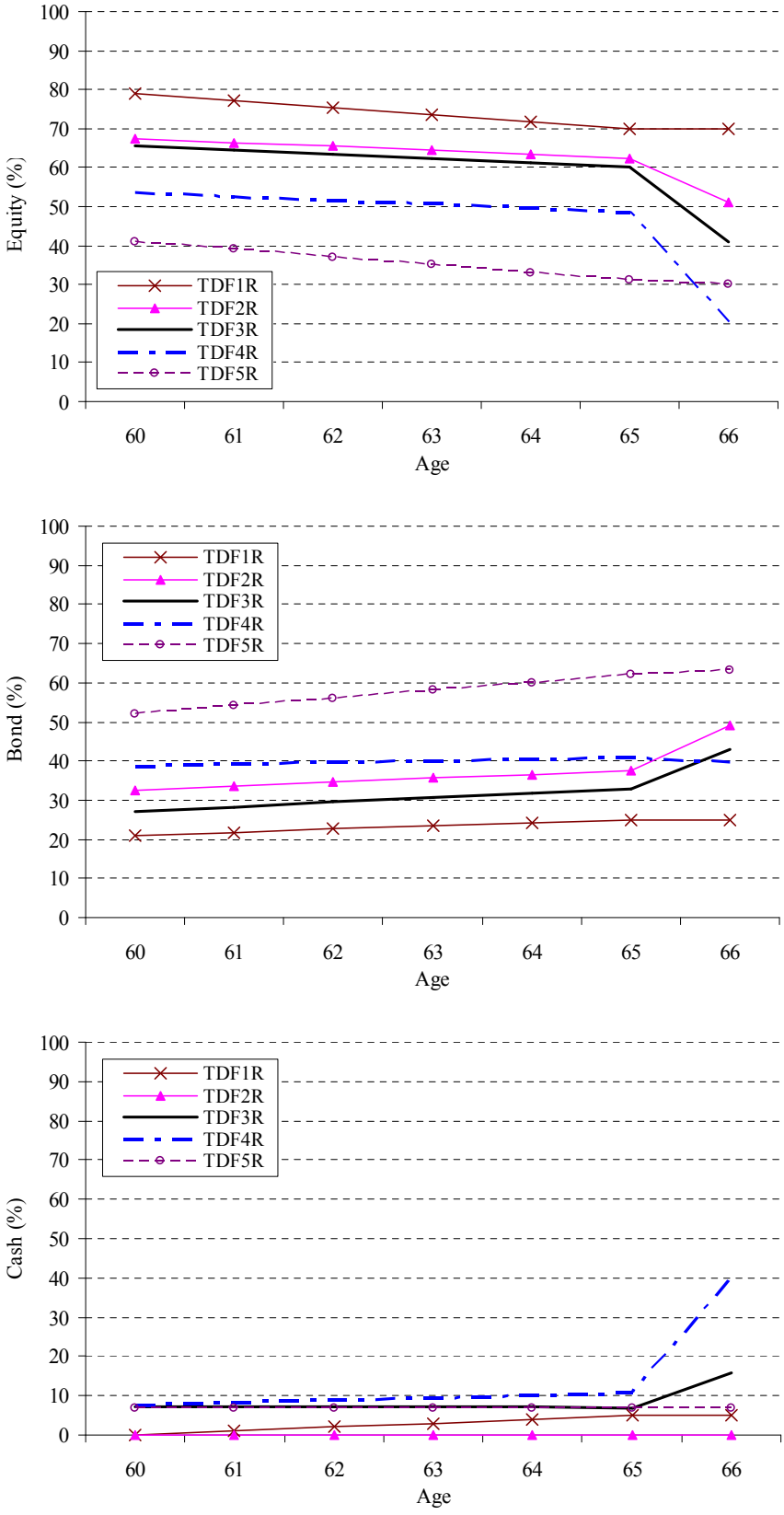
Notes: The percentiles of TDFs are identified by equity allocations in 2025 TDFs, with bond and cash allocations collected correspondingly. The glide paths are constructed by connecting all TDFs for each fund family. Allocations for ages between target dates are linearly interpolated.
Source: Authors' data collection from Morningstar and TDF providers' websites as of May 27, 2009.

We also consider older workers who start utilizing TDFs just years before retirement. As shown in Figure 3, there remains substantial variation in equity exposure. The equity share ranges from 40 to 80 percent just 5 years before retirement, shifting to a range of 30 to 70 percent upon retirement. The potential risk-return tradeoffs associated with these TDFs are worth particular attention because workers at this stage may have limited time to make up large investment losses, depending on their overall financial and employment situation and their post-retirement income strategies.

For a comparison of income strategies for retirees (discussed later), we also collect the data on asset allocations in the respective final retirement income funds. When an income fund does not exist for a TDF family, we select the fund with an investment objective or style that is closest to that of an income fund. For simplicity, we assume that the portfolio transition to income funds is instantaneous at the point of retirement and that asset allocations maintain constant thereafter from age 66 onward. These assumptions are largely in line with practice, though a few income funds continue to reduce their equity exposure through years in retirement.

Depending on the strategy used to generate income flows supporting the living standard in retirement, the bond allocations can play a particularly important role for retirees. This is because bonds can be part of the hedging strategy against fluctuations in annuity purchase prices which owe to changes in interest rate. As shown in Figure 3, some TDFs shift heavily to bonds while others to cash in the transition into retirement, which will importantly affect the level and volatility of income flows from various income strategies.

Figure 3. TDF Asset Allocations for Retiring Workers



Notes: The percentiles of TDFs are identified by equity allocations in 2015 TDFs, with bond and cash allocations collected correspondingly. The glide paths are constructed by connecting all TDFs for each fund family. Allocations for ages between target dates are linearly interpolated.
Source: Authors' data collection from Morningstar and TDF providers' websites as of May 27, 2009.

III. Simulations of Investment Returns

We simulate the range of investment outcomes according to TDFs' equity-bond-cash allocations, based on a stochastic model estimated on historical asset rates and returns. Equity, bond and cash returns are proxied by the S&P500 Total Return Index, the 5-year Government Bonds Total Return Index and 90-day Treasury bills, respectively. Values in this analysis are in real terms, that is, after adjusting for inflation, which is measured by the change in the CPI-U index. For the simulations of annuity purchase price (discussed later), the underlying discount rate is proxied by the 5-year T-note zero-coupon yield.

The dynamics of rates and returns are jointly modeled as a vector autoregressive (VAR) process. This approach captures the serial correlations among variables and the contemporaneous correlations of market shocks. The VAR coefficients and variance-covariance matrix, estimated on the 1962-2008 quarterly data, are embedded in the simulations to generate a large number of multiple-year series of rates and returns. The VAR model also reproduces the persistent shifts in risks and expected returns over long periods of time and the differing correlations of asset returns over short versus long horizons. Table 2 summarizes the basic statistics of the simulated rates and returns.[3]

Table 2. Statistics of simulated nominal rates and returns

	Equity return	Bond return	T-bill rate	Bond yield	Inflation rate
Mean (%)	8.8	6.4	5.1	6.2	4.0
Std. Dev. (%)	17.1	6.7	2.6	2.5	2.8
Short-run cross correlations (annual frequency)					
Equity return	1.00				
Bond return	0.16	1.00			
T-bill rate	0.12	0.26	1.00		
Bond yield	0.15	0.38	0.94	1.00	
Inflation rate	-0.08	-0.09	0.71	0.59	1.00
Long-run cross correlations (10-year frequency)					
Equity return	1.00				
Bond return	0.51	1.00			
T-bill rate	0.40	0.75	1.00		
Bond yield	0.44	0.81	0.98	1.00	
Inflation rate	0.25	0.46	0.87	0.81	1.00

Source: Authors' simulations based on a VAR model, using quarterly data over 1962 through 2008 from Global Financial Data.

[3] The VAR specification follows Campbell and Viceira (2004, 2005). Details of the estimation and simulations are described in a technical appendix, available from the authors upon request. The model is also used in Pang and Warshawsky (forthcoming). It is difficult to predict whether future rates and returns will significantly deviate, upward or downward, from these long-run levels. We make no judgment modifications on the VAR-based expectations.

Mutual funds charge certain fees and expenses. Wealth and income generated by mutual funds vary substantially with different levels of fees, arising from factors such as the bargaining power of the investors, market competition, product differentiation, etc. TDFs here are assumed to charge 75 basis points on account balances, regardless of asset compositions. This is the average level of expense ratio among TDFs on the market that are offered to institutional customers, as reported in Table 3. This analysis compares investment outcomes net of these expenses. The wealth delivered to investors would be significantly lower if expenses on retail terms were assumed.

Table 3. Expense ratios for target-date funds (%)

	Min	Mean	Max	No. of Obs.
Institutional pricing only	0.18	0.75	1.10	118
Retail & institutional pricing	0.18	1.24	2.45	644

Source: Authors' data collection.

IV. Risk-Return Tradeoffs of TDFs: Simulated Results

Early-Career Workers

We initially evaluate TDFs in terms of the amount of retirement wealth accrued upon retirement and the attendant level of risk. All terminal values are adjusted into real terms by simulated inflations. Our analysis first considers a hypothetical, prototypical DC plan participant who from the start of her career voluntarily selects or involuntarily defaults into one of the five life-cycle funds in Figure 1. She is assumed to earn $40,000 at age 25 and receive a 4 percent annual raise in nominal terms until age 55 and then 3 percent until retirement at age 65. The combined employer and employee contribution to her DC account is assumed to be 9 percent of pay.

Table 4 reports the probability distribution of realized inflation-adjusted retirement wealth for this long-horizon investor, out of a large number of simulations (100,000 40-year series). The 5th and 95th percentiles of terminal balance indicate "bad" and "good" outcomes, respectively, each with a 5 percent chance. The 1st and 99th percentile simulated outcomes indicate the magnitude of extreme values.

Two initial inferences can be made. First, the differential in final balances among these five TDFs is small. After 40 years of investment, the highest mean balance is $360,800, from TDF3E, approximately $22,000 higher than the lowest mean, from TDF2E. The worst outcomes (1st percentile) differ even less among these five TDF families. This is because of the frequent switch-overs of equity exposures in the glide paths. For instance, TDF2E starts with a greater equity share than TDF5E's, crosses the path of TDF5E in the investor's mid-40s and settles with a lower equity position at retirement than TDF5E.

Second, investment risk remains substantial regardless of which TDF is utilized. The bad investment outcomes will be deeply disappointing for investors holding higher expectations (say, around the "mean") which may have been illustrated to them. As such, while it is possible for a TDF to deliver a superb outcome, it is illusory to expect a TDF

to ex ante guarantee a certain balance on the target date, such as would occur with, for example, a cash balance pension plan accrued over a long career.

Table 4. Simulated Terminal Wealth at age 65 ($000, real) for an Early-Career Investor

	Percentiles of outcomes								Std.
	1st	5th	25th	50th	75th	95th	99th	Mean	Dev.
TDF1E	162.9	201.3	273.1	339.6	422.1	583.0	732.2	358.8	119.9
TDF2E	167.1	201.9	266.9	323.4	394.7	525.7	644.8	338.8	100.9
TDF3E	164.7	203.1	275.5	341.6	424.6	584.2	730.8	360.8	119.2
TDF4E	167.5	203.0	270.8	329.6	403.9	543.7	669.7	346.0	105.9
TDF5E	166.2	203.1	272.7	334.2	411.8	558.2	692.1	351.8	111.0

Source: Authors' simulations.

Mid-Career Workers

We next look at the range of possible outcomes for a mid-career DC plan participant who invests in a TDF for ages 50-65 (glide paths in Figure 2 above). We assume that she has accumulated personal savings of $200,000 and that her annual earnings are $75,000 at age 50. Other assumptions are identical to those for the early-career worker. Table 5 reports the probability distribution of simulated terminal wealth at 65.

Generally, a higher equity allocation produces greater wealth balance in expectation (median and mean outcomes), provided that the historically observed equity premium is sustained in the future, as implicitly assumed in the VAR simulations of asset returns. These TDFs generally maintain their relative positioning of equity exposure in the 15 years before retirement, which makes the risk-return tradeoffs clearer: for instance, TDF1M, with the highest equity allocation, has the potential of generating about $968,000 (95th percentile outcome), a sizable difference of some $196,000 from the corresponding outcome that can be generated by TDF4M. On the other hand, when equity markets perform poorly, the downside risk is mitigated (and lower standard deviation) in the TDF with lower equity exposure. At the 1st percentile outcomes, TDF4M outperforms TDF1M by about $27,000 in real terms. There is an early cross-over in equity allocations between TDF4M and TDF5M (Figure 2), which shows up in the simulated results; TDF4M actually performs better in down markets, despite starting with a higher equity share than TDF5M.

Table 5. Simulated Terminal Wealth at age 65 ($000, real) for a Mid-Career Investor

	Percentiles of outcomes								Std.
	1st	5th	25th	50th	75th	95th	99th	Mean	Dev.
TDF1M	203.3	259.3	377.1	492.6	646.2	968.0	1304.8	537.6	229.7
TDF2M	219.5	273.8	379.4	479.9	609.2	866.1	1122.1	513.4	188.6
TDF3M	219.2	272.7	376.7	475.5	601.6	852.2	1102.5	507.9	185.0
TDF4M	230.4	280.3	374.0	459.6	567.4	772.5	971.7	484.6	155.6
TDF5M	227.9	279.2	376.4	466.6	580.6	802.3	1017.6	494.0	165.3

Source: Authors' simulations.

Workers Approaching Retirement

Last, we examine the risk-return tradeoffs for a late-career investor who starts utilizing a TDF just 5 years before retirement (glide paths in Figure 3 above). The worker is assumed to earn $100,000 at age 60 and have an account of $500,000.

As reported in Table 6, higher equity exposure again generally implies opportunities for a greater wealth balance. If the top priority for a retiring investor, however, is protection of her wealth, ahead of the pursuit of wealth growth, then certain investment strategies may dominate. This may be because, for instance, as her career is approaching the end, the worker has few working years to make up investment losses and intends to use exclusively a fixed income strategy in her retirement. Despite the general shift from equity to bonds and cash towards the target date, poor investment performance may still substantially erode an investor's TDF balance. Specifically, the 1st and 5th percentile outcomes in Table 6 are far below the investor's initial principal plus new contributions. A TDF with lower equity exposure will help mitigate this downside risk – for instance, the lower-end outcomes in TDF5R are significantly higher than those in TDF1R, $406,000 compared to $350,000 at the 1st percentile outcomes and a lower standard deviation. Here there are no cross-overs in glide paths, except at the very end for TDF4R and TDF5R, as shown in Figure 3.

Investors may assess the reward from equity investment by adjusting for the added risk or variability in returns. For this purpose, we calculate the Sharpe ratio, which measures the excess return (or risk premium) per unit of risk in an investment portfolio. Excess returns here are defined as the difference between TDF returns and cash returns over the whole investment horizon. The Sharpe ratio is then calculated as the mean divided by the standard deviation of the excess returns. The Sharpe ratios in the last column of Table 6 indicate that TDF4R and TDF5R provide greater risk-adjusted returns than TDFs with larger equity exposures. These results are compatible with the essence of TDFs that retiring workers are generally better off by reallocating their wealth into safer assets.

Table 6. Simulated Terminal Wealth at age 65 ($000, real) for a Retiring Investor

	Percentiles of outcomes								Std.	Sharpe
	1st	5th	25th	50th	75th	95th	99th	Mean	Dev.	Ratio
TDF1R	349.6	420.7	547.6	660.6	797.1	1051.2	1273.7	687.9	196.1	0.655
TDF2R	365.2	433.2	552.9	657.2	781.8	1007.6	1202.6	680.3	178.1	0.690
TDF3R	371.4	437.7	552.8	652.6	771.3	985.9	1169.8	674.1	169.7	0.686
TDF4R	391.2	452.5	556.6	644.2	747.0	926.9	1076.9	661.0	146.4	0.725
TDF5R	405.8	462.3	556.6	634.0	723.1	873.8	1001.5	646.8	126.7	0.764

Source: Authors' simulations.

Income Strategies for Retirees

The analysis thus far is complete for investors who are only concerned about their "terminal" balance at the point of retirement or even considering the possibility of early, in-service or upon job exit, withdrawals. Others, however, who have a broader and

longer-term viewpoint, may consider the ultimate goal of a retirement plan, which is to produce income once retired from work.

We consider three alternative strategies for income once TDF investors are retired: a systematic withdrawal of a fixed percentage of account balance, a systematic withdrawal of fixed nominal amount, or a one-time complete conversion at end of age 65 to a life annuity with fixed nominal lifetime payout. The systematic withdrawal strategies carry the risk of outliving wealth but keep the possibility of leaving a bequest and liquidity for emergencies, while a fixed payout life annuity provides nominal income stability and insurance against longevity risk. Specifically, the fixed percentage is set to 7 percent and the fixed nominal amount $55,000 (which is roughly equal to 7 percent of the average TDF balance at retirement). These amounts are intended to generate a similar average level of nominal income in the first year of retirement as is delivered by certain assumptions about pricing of a single premium straight immediate life annuity. Higher (lower) percentages or amounts would by construction generate lower (higher) fund balances, with the income outcomes being less comparable to the annuity payouts.

The underlying assets for fixed life annuities are assumed to be invested in nominal bonds. The calculation of the annuity factor uses the government bond yield, which is stochastic through time and is jointly simulated in the VAR model. Insurance companies also invest in corporate bonds, getting somewhat higher yields, but we assume that the credit spread is used to cover investment expenses and bond defaults. The annuity pricing also uses annuitant (unisex) life table to reflect adverse selection in the voluntary immediate annuity market, and there is a load of 10 percent to cover administration, marketing and other costs.

The survival of retirees from age 66 onward is simulated based on general population unisex life table. Observations of investment returns are ignored in the years following the simulated death of an investor. The probability distributions of retirement income are reported in Tables 7 through 9 and Figures 4 through 6. For clarity, these income results are generated by making systematic withdrawals from fund balances over ages 65 through 100 or by converting age-65 balances entirely into life annuities. The probability distribution of age-65 balances was reported in Table 6.

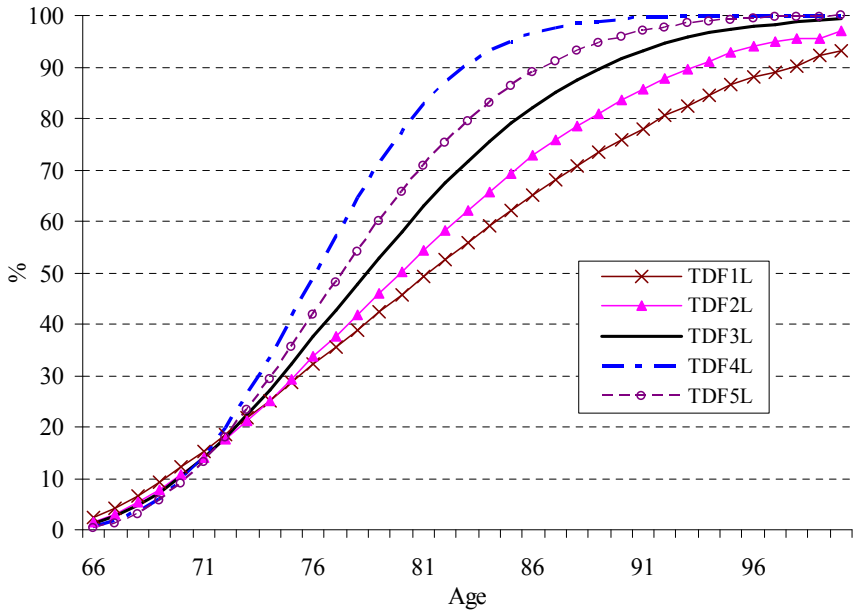
For the fixed percentage systematic withdrawal, TDF1R and TDF2R exhibit the best overall outcomes, even though they have the highest equity exposure. Through this withdrawal mechanism, these two funds deliver volatile incomes (larger standard deviations), but the probabilities of income falling below $25,000 over retirement life are lower than for other TDFs (last column of Table 7). Even at the 1st percentile outcomes, these TDFs generate higher income flows than apparently lower-risk TDFs. They do imply slightly higher shortfall risks in the early years of retirement, as shown in Figure 4. Over the long horizon in retirement, however, the greater equity return in general serves to deliver more financial resources for longevity. In contrast, large bond/cash positions in TDF4R and TDF5R, though with lower standard deviations, limit the rate of wealth growth and thus distribute lower income for consumption in retirement.

Table 7. Probability distribution of simulated income outcomes ($000, real) over all years in retirement, conditional on survival - systematic withdrawal of fixed 7% of balance

	Percentiles of outcomes									
	1st	5th	25th	50th	75th	95th	99th	Mean	Std. Dev.	Prob. <$25k
TDF1R	8.7	13.0	22.5	31.7	42.9	63.3	82.1	34.0	15.9	31.8
TDF2R	8.9	13.0	21.9	30.6	40.9	58.7	74.3	32.5	14.3	33.7
TDF3R	8.6	12.4	20.8	29.2	39.0	55.3	69.3	30.9	13.4	37.5
TDF4R	7.6	10.9	18.6	26.6	35.8	50.2	61.6	28.0	12.3	45.1
TDF5R	8.4	12.0	20.1	28.1	37.0	50.3	60.7	29.2	11.9	40.2

Source: Authors' simulations.

Figure 4. Probability of real income falling below $25,000 – systematic withdrawal of fixed percentage



Source: Authors' simulations.

For the systematic withdrawal of a fixed amount, the relative positioning of these TDFs remains the same as in the fixed percentage withdrawal, but the differential of risks and returns among them is narrower (Table 8 and Figure 5). Several steps help explain this result: First, the fixed nominal amount withdrawal plus the same stochastic inflation rates yields identical probability distribution of real income across TDFs, if full amount withdrawals *were* always available (i.e., no depletion of wealth). Second, the fixed amount withdrawal strategy is less likely to preserve resources for later life but the depletion generally happens only at advanced ages. The flow of income associated with one TDF may last a few more years than with another, for instance, until age 85 versus age 90. The real value of the nominal withdrawals at these advanced ages, however, may have fallen substantially, owing to 20+ years of inflation. High mortality rates have also eliminated many observations of exceptionally high values that would otherwise exceed the $25,000 threshold. Thus, the risk profiles of income falling below $25,000 are more compact in Figure 5 than in Figure 4. Third, when investment returns are high, across all the TDFs, a fixed nominal dollar withdrawal will leave assets for a bequest (not shown

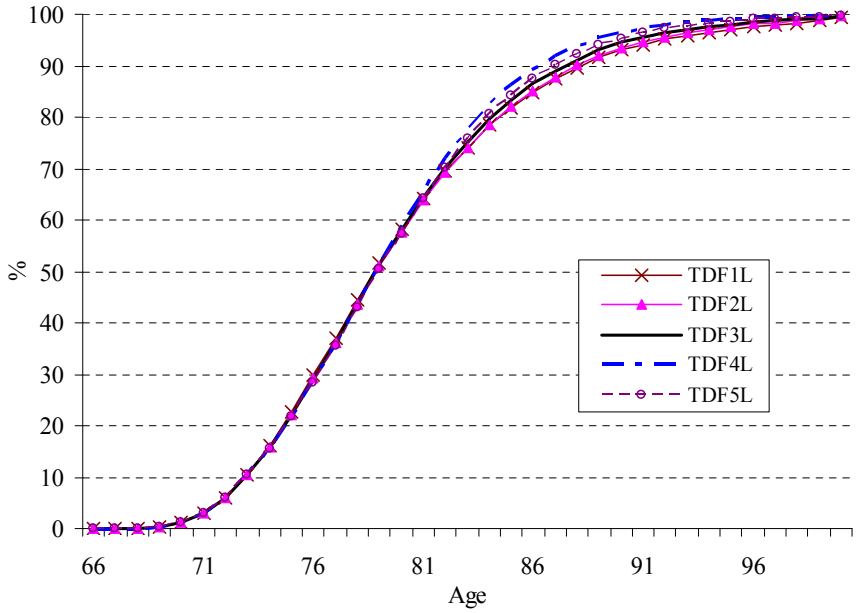
here), not boosting income. Nonetheless, we can see that the risk of wealth being entirely depleted and thus income being zero is generally lower for TDFs with higher equity holdings because a higher growth rate of wealth is sustained on average. As shown in the last column of Table 8, the likelihood of income being zero is greater for TDF4R with lower equity investment than for TDF1R and TDF2R.

Table 8. Probability distribution of simulated income outcomes ($000, real) over all years in retirement, conditional on survival - systematic withdrawal of fixed nominal $55,000

	Percentiles of outcomes							Std.	Prob.	Prob.
	1st	5th	25th	50th	75th	95th	Mean	Dev.	<$25k	= $0
TDF1R	0.0	22.0	30.7	38.5	47.3	53.1	29.5	12.4	32.8	5.7
TDF2R	0.0	22.1	30.8	38.5	47.3	53.1	29.6	12.3	32.7	5.5
TDF3R	0.0	21.9	30.7	38.5	47.3	53.1	29.4	12.5	33.0	6.0
TDF4R	0.0	21.6	30.6	38.5	47.2	53.1	29.1	12.8	33.5	7.2
TDF5R	0.0	21.9	30.7	38.5	47.3	53.1	29.4	12.5	33.0	6.0

Source: Authors' simulations.

Figure 5. Probability of real income falling below $25,000 – systematic withdrawal of fixed nominal amount of $55,000



Source: Authors' simulations.

If investors plan to annuitize their wealth upon retirement and correspondingly want to integrate this income strategy with their choice of TDF investment in working years, the results in Table 9 offer a useful reference and give a different indication of investment strategy than if fixed systematic withdrawals are being made. TDF4R and TDF5R here give more security in terms of lower volatility (standard deviation) of income and better performance in down markets, owing to their lower equity exposure, at some cost of forgoing upside potential. Also note that TDF5R is somewhat more secure than TDF4R, albeit a higher equity exposure at retirement, likely because TDF5R has a larger bond position at retirement, which serves as a better hedge to the annuity purchase. And note

that the annuity strategy will generally produce higher income flows, across probability percentiles and TDFs, compared to the systematic withdrawal strategies, owing to its mortality pooling properties, although at the cost of a loss in bequest potential and liquidity.

The risk-return tradeoffs differ in the short- versus long-term perspectives in this strategy. As shown in Figure 6, the risk of income falling below $25,000 is generally small across all TDFs in the investor's early years in retirement, but relatively larger for TDFs with larger equity exposure (for instance, TDF1R although barely noticeable in the figure). As time elapses, however, the erosion of inflation makes the lower-equity-TDF financed annuities somewhat more likely to fall short in terms of real purchasing power. This is because TDFs with lower (higher) equity allocations generally create smaller (larger) account balances, thus leading to lower (higher) levels of nominal annuity payout at the one-time annuity conversion.[4]

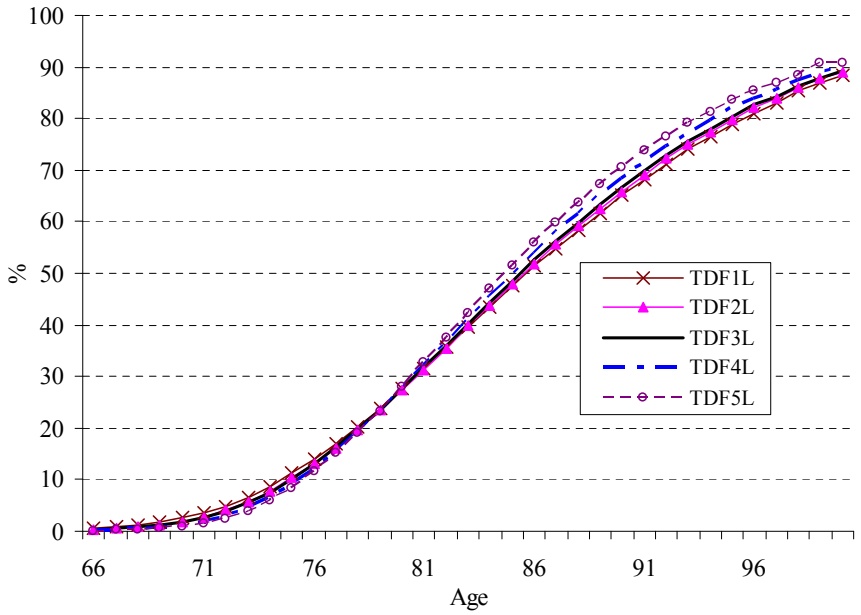
Table 9. Probability distribution of simulated payouts ($000, real) over all years in retirement, conditional on survival - single premium fixed nominal payout life annuity

	Percentiles of outcomes								Std.	Prob.
	1st	5th	25th	50th	75th	95th	99th	Mean	Dev.	<$25k
TDF1R	10.9	16.2	27.8	38.5	51.4	74.8	95.7	41.1	18.3	19.1
TDF2R	11.1	16.5	28.0	38.4	50.7	72.2	90.9	40.6	17.3	18.6
TDF3R	11.1	16.4	27.9	38.2	50.2	71.1	89.2	40.3	17.0	18.8
TDF4R	11.3	16.6	27.9	37.9	49.1	67.8	83.4	39.4	15.8	18.7
TDF5R	11.4	16.7	27.7	37.4	47.9	64.5	77.7	38.5	14.7	18.8

Source: Authors' simulations.

[4] Note that the mortality rate is much lower in early years in retirement, and thus there are a larger number of observations for this period, than in later years. The last column of Table 9 shows a larger shortfall risk for TDFs with greater equity exposure. This simply reflects the above tilt in mortality-linked observations. It should thus be clarified that a safer TDF portfolio may bear the cost of potentially lower purchasing power for advanced ages, as shown in Figure 6.

Figure 6. Probability of real income falling below $25,000 – single premium fixed nominal payout life annuity



Source: Authors' simulations.

V. Conclusions

Through stochastic simulations, we compare risk-return tradeoffs for target-date funds that have different initial asset allocations and subsequent glide patterns. Target-date funds are an improvement over the status quo given that most DC plan participants seem to hold non-optimal portfolios. Target-date funds are nonetheless risky because the expected returns through the better diversified, age-specific, and dynamic asset reallocations are no guarantee. One way to reduce "terminal" balance risk is to reduce the equity exposure toward the end of a career and increase cash. But that is not necessarily the optimal strategy if the goal is an adequate retirement income flow over many years in retirement life. If a fixed systematic withdrawal is the desired income strategy, a larger allocation to equities has a better prospect of delivering income for advanced ages. If a life annuity is the desired income strategy, the lower risk strategy is a larger allocation to bonds, rather than to cash.

The optimal asset allocation depends on a number of specifics for the individual including personal characteristics and other benefits offered. For instance, if a company offers a defined benefit pension plan in parallel, the safe pension benefit establishes an income floor and thus accommodates a more aggressive TDF portfolio. Similarly lower income individuals get a significant portion of their retirement benefits from Social Security, which would allow for a larger portion of their individual account balance in equity. As a result of the complexity and variety of situations, it is challenging for regulations or legislation to set asset allocation constraints that foster "mass suitability" for a majority of TDF investors. Rather, simple, understandable and realistic disclosure

plus enhanced sponsor and participant understanding and evaluation is essential, so that the appropriate TDF options can be selected.

References

Bodie, Zvi, Robert Merton and William Samuelson. 1992. "Labor Supply Flexibility and Portfolio Choice in a Life-Cycle Model." *Journal of Economic Dynamics and Control*, Vol. 16, pp. 427-449.

Campbell, John and Luis Viceira. 2004. "Long-Horizon Mean-Variance Analysis: A User Guide." Appendix for "The Term Structure of the Risk-Return Tradeoff."

Campbell, John and Luis Viceira. 2005. "The Term Structure of the Risk-Return Trade-Off." *Financial Analysts Journal*, Vol. 61, No. 1, pp. 34-44.

Pang, Gaobo and Mark Warshawsky. *Forthcoming*. "Comparing Strategies for Retirement Wealth Management: Mutual Funds and Annuities." *Journal of Financial Planning*.

Poterba, James, Joshua Rauh, Steven Venti, and David Wise. 2006. "Reducing Social Security PRA Risk at the Individual Level – Lifecycle Funds and No-loss Strategies." Prepared for the 8th Annual Joint Conference of the Retirement Research Consortium.

TIAA-CREF. 2007. "What's Up with Lifecycle Funds?" *Weekly Market Monitor,* Dec. 10.

Viceira, Luis M. Francisco J. Gomes and Laurence J. Kotlikoff. 2008. "Optimal Life-Cycle Investing with Flexible Labor Supply: A Welfare Analysis of Life-Cycle Funds." *American Economic Review: Papers and Proceedings*, Vol. 98, pp. 297-303, May.

Young, Lauren. 2008. "Target-Date Funds Hit Their Stride." *Business Week,* The 2008 Retirement Guide, July 3.