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Target-date investment strategies purport to meet the two primary objectives of any retirement savings program: maximize the real value of our nest eggs, and minimize uncertainty around the prospective income we'll have at our disposal as we approach our retirement years. Unfortunately, the classic glidepath approach to retirement investing—moving from equity-centric to bond-centric investing as we age—does not meet these objectives.

We summarize the flaws in traditional glidepath implementation and explore illustrative changes to the rules-based, mechanistic solution for retirement planning that can improve the expected outcome for investors. We use simulations to test alternatives and find the following: First, rebalancing to a static mix beats a gradual shift to bonds (or equities for that matter, because the solutions are not linked to expected market environments). Second, adjusting the risk profile *within* stock and bond portfolios rather than *across* asset classes reins in risk more constructively than the classic glidepath solution. Third, incorporating valuation-indifferent equity strategies improves the historical performance of the solutions relative to alternatives built using cap-weighted equity indexes.

Even with simplistic, rules-based approaches, we find there are better ways to achieve our financial objectives for retirement.

The conventional wisdom on investing for retirement is that young adults should buy stocks and mature adults should favor bonds. Intuitively, this makes sense. Young people have modest savings and lots of time to recoup losses. People approaching retirement have more to lose and less time to recover from bear markets. Typically, we also want greater certainty as to how much we can safely spend in retirement and less risk that a decline in the value of our investments will demolish our retirement plans.

This type of logic permeates our retirement investment solutions industry. One of the fastest-growing applications is the wide array of target-date strategies, whose glidepath mechanism systematically ramps down portfolio volatility by migrating from an equity-centric portfolio to a bond-centric portfolio as employees approach retirement.[1] For many of us, these products are the default option in our 401(k) and other defined contribution pension portfolios.

We believe that the heuristic of buying stocks when young and bonds when mature—a rule of thumb by which many billions are invested—is flawed, and that the typical glidepath implementation fails to solve the basic problems facing most investors. Since their inception, conventional glidepaths have fallen short of contrarian strategies or ordinary balanced strategies. They offer more, not less, uncertainty about prospective real

retirement income. Most people typically buy a formulaic asset mix, regardless of valuation levels or yields. And yet, they collect steadily accelerating new asset flows, because the target-date story is so compelling![2]

Retirees deserve better advice and solutions. In this article, we illustrate areas where conventional glidepath approaches are problematic for investors—particularly in the market environment facing us today, which, we believe, will persist for years to come. We also outline possible rules-based solutions that address the glaring pitfalls in the typical target-date solution. Our alternatives are deliberately simple, so that they illustrate our points vis-à-vis existing target-date alternatives; we acknowledge (and believe) that skilled active managers can achieve superior results, particularly when they customize these solutions for an individual investor.

A FLAWED IMPLEMENTATION

The two primary objectives of any retirement savings program are to 1) maximize, subject to reasonable risk controls, the real value of our retirement nest egg, and 2) minimize uncertainty around the prospective retirement spending that we will have at our disposal as we approach retirement. Meeting these objectives is hard enough for professional investment managers; it has proven to be almost impossible for many individual investors, who are now responsible for their own investment decisions. Target-date funds (TDFs), with their embedded asset allocation glidepaths and prefab investment management (or index fund) structures, offer a logical "solution" for plan sponsors and their employee participants.

The basic premise for TDFs is that we should be more aggressive when we're young and can ostensibly tolerate more risk, and more conservative in later years, when downside risk could compromise our retirement plans and prospective retirement income. Therefore, the classic glidepath strategy starts with a heavy equity allocation and gradually switches portfolio holdings into bonds as the target date approaches. The core presumption is that this glidepath gives the investor 1) more end-point wealth, and 2) less uncertainty, as compared with alternative strategies, when it comes to estimating retirement income during the later years of wealth accumulation.

Unfortunately, the implementation of these strategies falls short on both counts.[3] To illustrate our points, we simulated how the approach would have worked in the past for three simple allocation strategies, assuming a consistent real (inflation-adjusted) $1,000 annual contribution over a 41-year career and annual rebalancing and ignoring both taxes and transaction costs.[4] These strategies are:

1. Glidepath: The allocation ramps down from an 80/20 stock/bond allocation to a 20/80 bond-centric allocation.
2. Balanced (static): The allocation is rebalanced annually to a static 50/50 stock/bond allocation.
3. Inverse Glidepath: The allocation ramps up from a 20/80 stock/bond allocation to an 80/20 equity-centric allocation.

We used 141 years of stock and bond market returns from 1871 to 2011, so our first breadwinner starts working in 1871 and retires at the end of 1911, and our last breadwinner starts in 1971 and retires at the end of 2011. This gave us 101 different investment experiences.

The results of that research, illustrated in Exhibit 1, show that the typical glidepath allocation does not meet the primary objectives for a retirement solution: the glidepath approach results in *lower* ending retirement assets than the balanced approach or the inverse glidepath approach (Panel A), *even for the extreme bottom tail of the distribution*. Consequently, the glidepath approach also fails to give us a higher ending real annuity (Panel B). And, rather more shocking, it doesn't give us greater confidence about our prospective retirement income, a mere 10 years from retirement, *again, even for the bottom of the distribution*.

We can use this simple analysis to highlight several points about the glidepath solution. First, the investment results are *very* dependent on market behavior. Note that our average allocation for all three approaches is 50/50. That doesn't mean all three methods will generate the same results. Markets don't care about our glidepath (or lack thereof); we're as likely to have our best stock market returns late in our career as early. If the best stock market returns come early, it's clear that we'll finish richer with a glidepath strategy. But if bonds beat stocks late in our career, we'll do materially worse with a glidepath approach.

Second, while it's clear that all three strategies average a 50/50 stock/bond mix, on average over our 41-year investment horizon, the *dollar-weighted* average allocation will be far more bond-centric with a classic

EXHIBIT 1

A Comparison of Retirement Strategies, 1871–2011

	Glidepath	Balanced Static	Inverse Glidepath
	80→20	50/50	20→80
Panel A: Ending Retirement Assets			
Average	$124,460	$137,870	$152,060
Std Dev	$37,670	$41,250	$57,010
Min	$49,940	$51,800	$53,040
10%ile	$73,550	$78,820	$79,300
50%ile	$119,760	$142,620	$148,240
90%ile	$177,400	$184,090	$227,670
Max	$211,330	$209,110	$286,920
90%/10% Ratio	2.41	2.34	2.87
Panel B: Ending Retirement Real Annuity			
Average	$7,730	$8,550	$9,440
Std Dev	$2,520	$2,780	$3,780
Min	$2,390	$2,540	$2,660
10%ile	$4,590	$4,590	$4,560
50%ile	$7,420	$8,280	$8,680
90%ile	$11,180	$11,760	$15,070
Max	$13,130	$14,470	$18,040
90%/10% Ratio	2.44	2.56	3.30
Panel C: Final 10-Year Change in Income			
Average	154%	193%	236%
Std Dev	82%	140%	218%
Min	−54%	−53%	−52%
10%ile	9%	15%	16%
50%ile	128%	142%	156%
90%ile	280%	349%	447%
Max	1302%	1759%	2316%
90%/10% Ratio	3.50	3.91	4.73

Source: Research Affiliates, based upon data from Schwert, Shiller, Ibbotson, and Bianco.

glidepath strategy: Our portfolio is small when we're equity-centric (early in life) and far larger later in life, by which time we have taken most of our equity chips off the table. Size matters. Having higher returns when our portfolio is large is important; over most historical spans, this means that finishing with an equity-centric asset mix trumps the classic glidepath strategy.

To a degree, our results are driven by the empirical fact that, over the entire observation period, stocks outperformed bonds. Had bonds outperformed stocks, as they did in the 10-year period following the peak of the tech bubble, investors with an investment horizon of 10 years or less would have done better with the first-generation glidepath solution. Of course, the opposite is true for investors in a rising interest rate environment, such as the 1950s. Whereas active managers can adjust for such environments, a simple rules-based, environment-indifferent solution should be positioned for the best outcome across the various possible environments.

The Arnott [2012] research was validated on a global scale by Estrada [2014], who looked at a comprehensive sample spanning 19 countries, two regions, and 110 years of data. Estrada found that on average across the 19 countries, all 10 alternative strategies considered provide investors with 1) higher mean and median terminal wealth, 2) higher upside potential, 3) a more limited downside risk, and 4) higher uncertainty about terminal wealth (Estrada notes that the alternative strategies' higher variability in terminal wealth merely represents higher *upside* risk). These results hold true in each of the 19 countries, without exception, which is quite a startling result.

BASIC DESIGN FLAWS OF THE GLIDEPATH SOLUTION

We believe that the idea of reducing risk closer to retirement is entirely natural for risk-averse investors. The typical glidepath solution does not achieve this goal, however, in part because of some basic design flaws. In our view, four factors contribute to the flawed design: 1) inefficient asset class exposure, 2) misspecification of risk and return, 3) poor diversification, and 4) constant risk premium assumptions.

Let's examine each of these.

Inefficient Asset Class Exposure

The trend in TDFs increasingly favors passive management, largely because it tends to be less expensive. Bauer et al. [2009] predict that over 80% of off-the-shelf target-date products will be passively managed by 2019. This transition is well underway, as illustrated by the shift in market share from Fidelity (active-oriented products) to Vanguard (passive-oriented products).[5]

But the cap-weighted indexes that serve as the basis for these funds are no panacea. If we simply accept the notion that prices imprecisely reflect true fair value, then cap-weighted indexes will lead to inefficient outcomes as they structurally will overweight overpriced stocks

(the future underperformers) and underweight underpriced stocks (the future outperformers), relative to the unknowable fair-value weight. By randomizing these errors, they will cancel, instead of pulling down our returns. The same bias holds true for bonds, where cap weighting is even more vulnerable to criticism: it links security and sector weights in proportion to both the price of the bond *and the debt appetite of the borrower.*

Numerous articles published over the past eight years demonstrate that almost *any* non-price-weighted approach, periodically rebalanced, produces better long-term results than cap weighting.[6] Non-price-weighted indexes, carefully constructed for efficient implementation, preserve many of the desirable characteristics of index fund investing—large capacity, economic representation, low turnover, and low trading costs—while eliminating the negative return drag from cap weighting.[7] This is particularly important in fixed income. As Baby Boomers near and cross the retirement date, their exposure to bonds—at negative real yields!—rises in cap-weighted indexes, as does their exposure to steadily rising government debt.

Misspecification of Risk and Return

The typical TDF structure assumes flawed measures of risk and return. For retirement purposes, it makes much more sense to gauge our success in terms of the annuitized income that our portfolio could provide rather than in terms of notional portfolio gains or losses. This means that our risk[8] is better measured by the volatility in our prospective retirement income than by the volatility in our pension portfolio value. This is a subtlety that gets far too little attention, but bears some exploration.[9]

Recall that the second objective of a retirement solution is to minimize uncertainty around our retirement prospects as we near retirement. Suppose we expect to retire 10 years hence. Do we want to predict our retirement account *balance* 10 years hence with more accuracy? That really doesn't tell us much, as it excludes inflation. What about the real value of the portfolio? This is only important if we plan to spend our nest egg right away. We're still missing the cost of an annuity, and the "entitlements" resources we may (or, perhaps more likely, may not) expect to receive. A far better measure is the real sustainable spending a portfolio is likely to deliver.

For most investors, the balance shouldn't matter nearly as much as the lifelong spending power that our defined contribution (DC) portfolio can sustain. Virtually every DC plan participant is familiar with Social Security. Even if we don't read our annual statements, we're likely expecting benefits. Do we speak of the net present value of our future Social Security benefits? Probably not. If we talk about it at all, we refer to the monthly benefit amount that we expect to receive. Likewise, the defined benefit pensioner speaks of his or her benefit as a monthly benefit, or perhaps as a percentage of final annual wages, not as a lump sum portfolio value (unless they choose lump sum distribution).

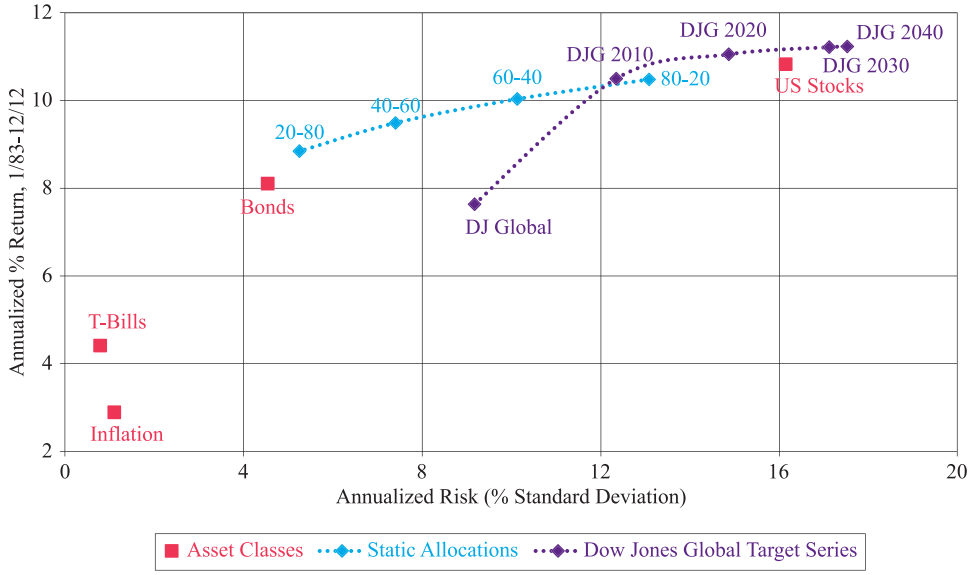
When we move into the world of 401(k) and DC plans, not to mention our savings and investment portfolios, we tend to focus on portfolio balances. Given inflation, a more reasonable definition of wealth would be the real, inflation-indexed annuity that our balances could purchase. The annuity will vary with our portfolio value, adjusted for both inflation and the real interest rates available to us. It is a means of converting that real value into long-term sustainable real income. The primary goal of a 401(k) investor ought, therefore, to be to increase this "sustainable real spending."

Just as we do in conventional risk/reward analysis, we should seek to minimize shocks or volatility in the sustainable real spending stream—*not the account balance per se*—especially as we get closer to retirement. This becomes critical in the wind-down years of a savings program (see Panel C of Exhibit 1). If our portfolio value stays flat but real interest rates drop, we may feel as though we haven't suffered a loss, but we have most assuredly witnessed a decline in our sustainable spending. Likewise, a decline in value, if accompanied by a sizeable rise in real interest rates, can, counter-intuitively, lead to greater wealth.

The following analysis demonstrates the dangers of misspecifying risk and return. Let's start with a simple evaluation of several asset classes and TDFs that follow a classical glidepath. We choose a suite of lifecycle benchmark portfolios, the Dow Jones Global Target Date[10] series (DJ Global), as a representative TDF suite. Exhibit 2 shows a conventional view of risk and reward beginning in January 1983, when the DJ Global series started. T-bills exhibit the lowest notional risk and the other asset classes and funds exhibit notional risk ranging from 1% to 18%.

EXHIBIT 2

Conventional Risk vs. Return, Glidepath Strategies vs. Static Allocations, January 1983–December 2012



Source: Research Affiliates, based upon data from Morningstar.

The picture changes materially when we shift to a real annuity framework,[11] where the emphasis is on growing the real annuity that we can afford to buy, while seeking to minimize variability in our prospective real income stream in retirement, rather than on notional risk and return. In Exhibit 3, "return" is the growth in the real annuity that we could afford to buy, given the joint consequences of the change in portfolio value *and* the cost of purchasing a real income stream, and "risk" is the volatility in future real spending power. With this shift in emphasis, not a single fund or asset class delivers less *true* (real annuity) risk than its notional volatility. In other words, the riskiness of the income stream is greater than the notional volatility of ending assets might suggest. Of course, TIPS are an exception, but we do not include TIPS in this analysis because they did not exist in the United States until 1997.

Note that whereas T-bills have near-zero risk in the conventional risk/reward framework, they give us huge uncertainty about our retirement income expectations: The real annuity that we could purchase would rise or fall by roughly 10%, on average, from year to year. This is an instructive example of how dangerous cash is as a retirement option.

In an era when bonds beat stocks on the risk-adjusted basis, it comes as no surprise that bonds have the highest Sharpe ratio, as Exhibit 4 shows. *But this Sharpe ratio is based on the wrong risk metric.* Let us stress this point: If we have a 10% return in any given year, while the cost of buying a real 20-year annuity rises in that year by 20%, we've actually lost ground to the tune of almost 10%.

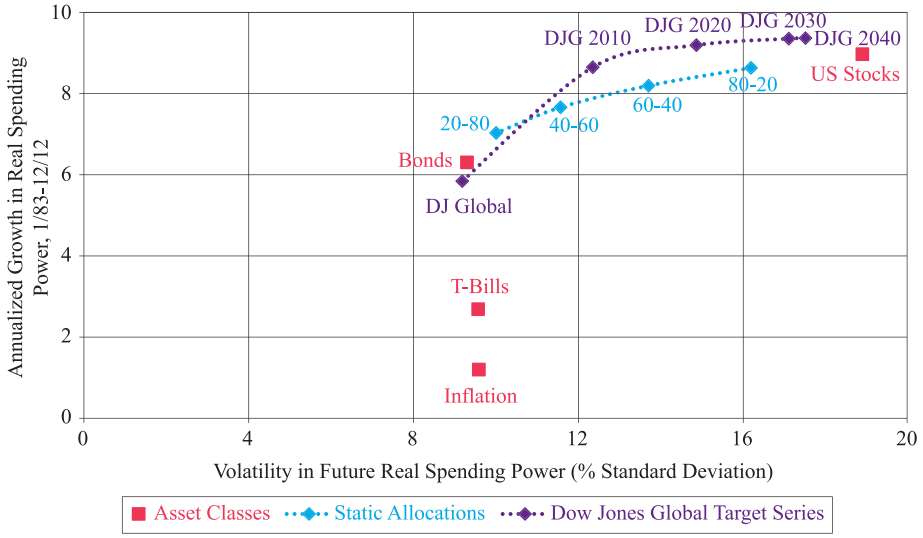
Accordingly, for the vertical axis in Exhibit 4, we compute a *Real Annuity Ratio*, which measures the annual growth rate in the real annuity that a given asset class or strategy permits us to buy, divided by the volatility in that same prospective real retirement annuity. This is essentially a Sharpe ratio, reconfigured to measure what really matters: the growth in the prospective long-term real income stream that our portfolio could purchase from one year to the next. As you can see, the attractiveness of the various options changes when the framework changes. More on this later.

Poor Diversification

Conventional TDFs tend to be poorly diversified. Equities are generally substantially more volatile than

Exhibit 3

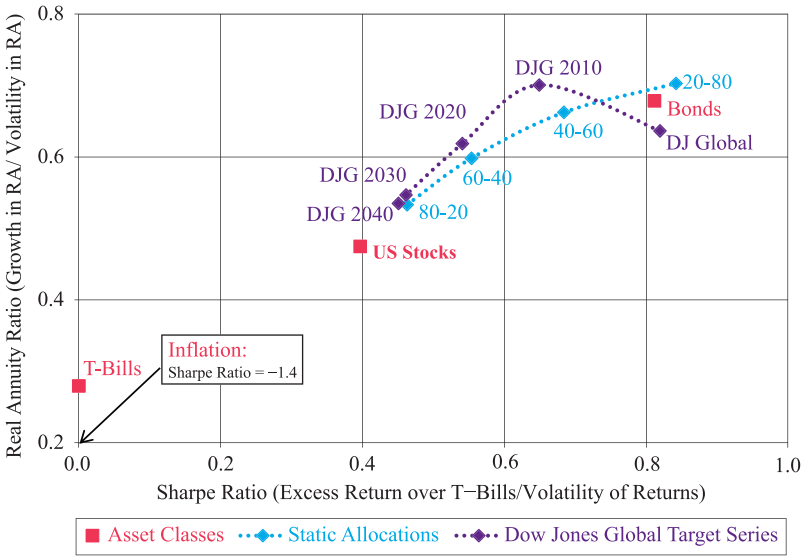
Real Annuity Risk & Return, Glidepath Strategies vs. Static Allocations, January 1983–December 2012



Source: Research Affiliates, based upon data from Morningstar.

Exhibit 4

Sharpe Ratio and Real Annuity Ratio, Glidepath Strategies vs. Static Allocations, January 1983–December 2012



Source: Research Affiliates, based upon data from Morningstar.

bonds,[12] and so account for most of the risk of TDFs. Most observers would be shocked to know that the classic 60/40 balanced portfolio (60% in stocks and 40% in bonds) has roughly a 98% correlation with the stock market.[13] This is entirely consistent with the risk postures of most balanced funds and institutional pension, foundation, and endowment portfolios.

One of the reasons for the concentration in equity risk is that most TDFs are building retirement portfolios on two pillars: mainstream stocks and bonds.[14] Stocks provide participation in the growth of the macro economy and bonds provide steady income while tamping down the volatility of our stock holdings. In a reflationary world, characterized by inflationary jolts that deplete the purchasing power of our portfolio and our retirement income, it's likely that a portfolio composed exclusively of stocks and bonds will not serve us well. Inflation triggers higher interest rates, which hurts our bonds very directly, while also increasing economic uncertainty, which drives down the valuation levels for stocks.

We have long advocated the use of three pillars for our retirement portfolios: stocks, bonds, and inflation hedges. The best-known inflation hedges are commodities when the economy is growing

and TIPS when the economy is faltering.[15] Commodity prices are pushed up by strong global demand; continued growth in emerging markets will likely fuel demand for (and shortages of) commodities. Like nominal bonds, TIPS prefer slower economic environments, because they benefit from falling interest rates and lose value when real rates rise. In addition to classic real return assets, we have identified a variety of "stealth inflation fighters," such as emerging market debt (especially if denominated in the local currency), high yield bonds, and bank loans; these can be added to our third pillar, as market conditions and yields dictate.[16]

The benefit of adding inflation hedges to the asset allocation can be seen in Exhibit 5, which presents a conventional evaluation of risk and return for various funds since 2000.[17] In addition to covering stocks, bonds, and cash, we included the Dow Jones Real Return (DJRR)[18] series, long TIPS, commodities, REITS, and an equal-weighted portfolio of 16 asset classes that we often use to illustrate a broadly diversified portfolio (labeled "All Asset").[19] Let's begin by observing that T-bills exhibit the lowest *conventional* volatility, and the other asset classes and funds exhibit notional volatility, ranging from 2% to 23%, with REITS yielding the highest annual return (over this *historical* span) for above-average risk. For both of the TDF series, the income strategy has the lowest risk, with risk ramping up as the target-date is extended. Both DJ Global and DJRR series show monotonic downward slopes, reflecting the fact that bonds beat stocks over this time span.

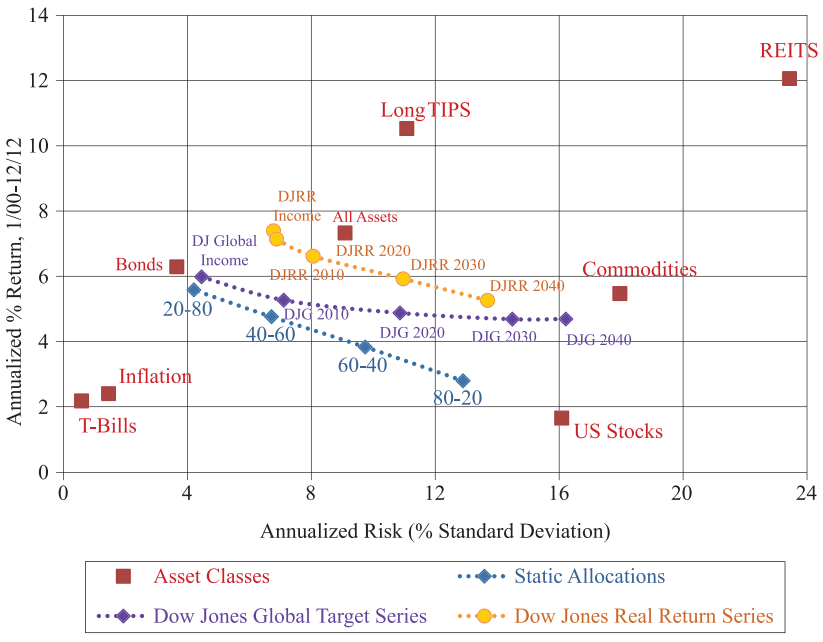
Exhibit 6 repeats the analysis in a real annuity framework. In this amended framework, long TIPS become our least-risky asset class, with less than 4% "Real Annuity" risk. This implies that if we invest in long TIPS, the real 20-year annuity that we can afford varies by an average of just 4% in any given year. This compares with 11% risk in a conventional risk/reward framework. In addition, only long TIPS deliver less *true* (real annuity) risk than their notional volatility. Commodities exhibit the same level of volatility in either the real annuity or the conventional framework. Most other asset classes and balanced portfolios have more real annuity volatility than notional return volatility. Every single fund, in every single TDF suite, delivers more volatility of prospective retirement income than simple notional volatility. Yikes.

It's worth noting that, under the real annuity framework, comparing real return funds to global funds of the same target date, the real return TDFs seem to be able to deliver higher real spending power for similar, or much less, risk. As shown in Exhibit 6, the DJRR income strategy provides higher annual growth in our real spending power than DJ Global income strategies, for nearly identical risk. In fact, DJRR 2010 manages to deliver a higher real spending power boost than DJ Global 2010, for about half of the risk. Similar patterns persist for 2030 and 2040 fund comparisons.

The benefit of adding inflation hedges in a real annuity framework becomes evident in Exhibit 7: Each fund in the DJRR TDF series gives us a better Sharpe ratio, and a better real annuity ratio, than the alternatives. Most of the strategies fall along the corridor from U.S. stocks (with a disappointing Sharpe ratio and a negative real annuity ratio) to U.S. bonds (with a great Sharpe ratio and a respectable real annuity ratio). T-bills have

EXHIBIT 5

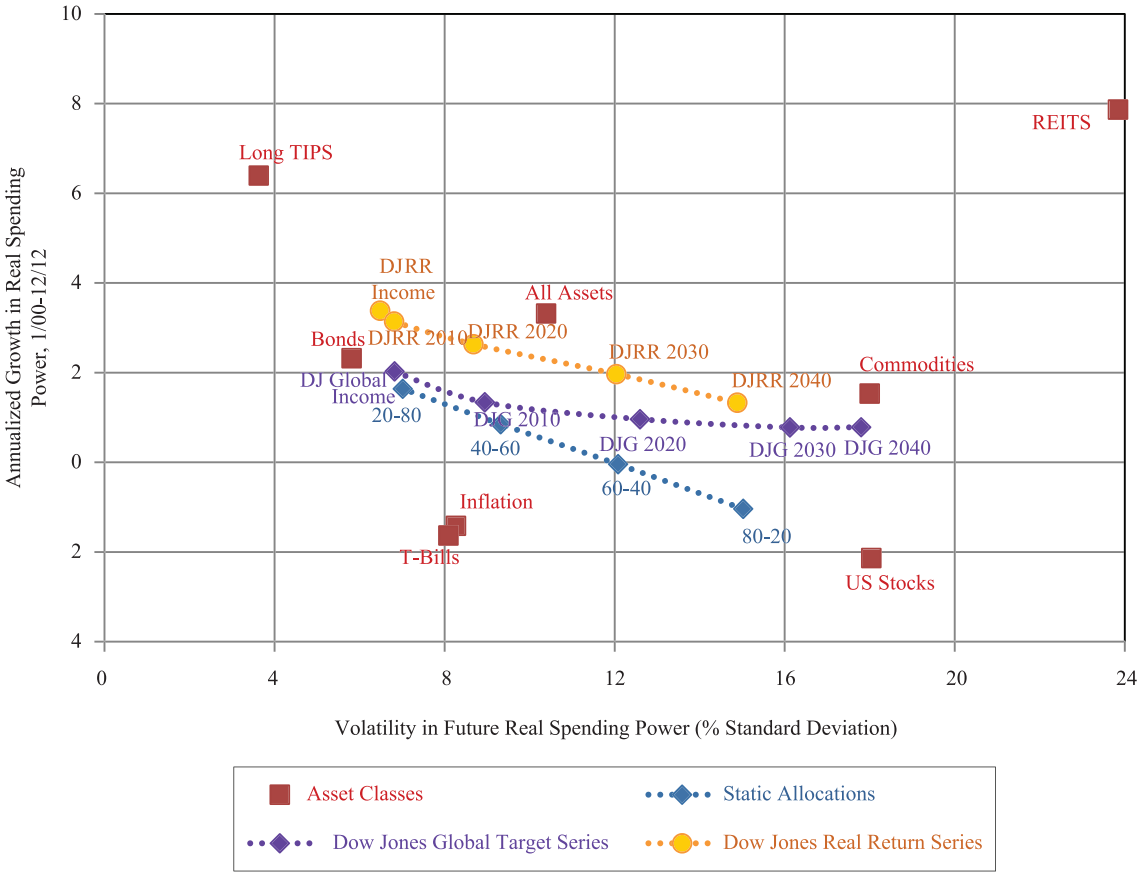
Conventional Risk vs. Return, Glidepath Strategies vs. Static Allocations, January 2000–December 2012



Source: Research Affiliates, based upon data from Morningstar.

EXHIBIT 6

Real Annuity Risk & Return, Glidepath Strategies vs. Static Allocations, January 2000–December 2012



Source: Research Affiliates, based upon data from Morningstar.

a zero Sharpe ratio, by definition, but deliver a truly awful real annuity ratio.

The biggest outlier—long TIPS, offering a real annuity ratio of 1.9—does not even show up on this graph, unless we radically rescale the vertical axis. The utter dominance of long TIPS in real annuity ratio is largely a function of the very low volatility in the real retirement annuity that this asset class will purchase from year to year.[20] With low TIPS yields (until recently, negative almost out to a 20-year maturity) this high real annuity ratio may be a thing of the past,[21] *but the stealth inflation hedges may still be valuable in helping us to achieve a solid real annuity ratio.*

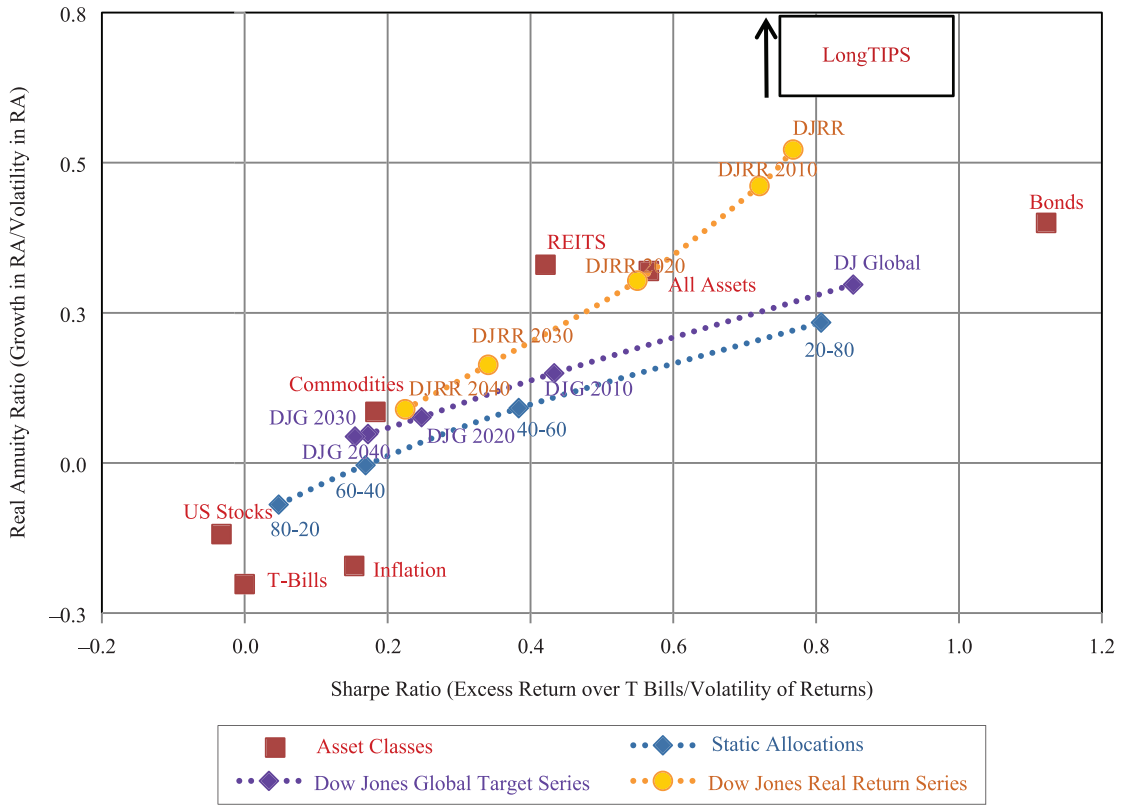
For investors who are confident that inflation will not be a serious issue in the coming 20 or 30 years, this third pillar can be a small allocation, serving as an insurance policy in case they're wrong. If we fear that our soaring debts will trigger inflationary shocks in the years ahead, perhaps the third pillar should be our largest pillar, bigger than the allocations to mainstream stocks and bonds. It would serve to protect our purchasing power as inflation exacts its toll on mainstream holdings.

Constant Risk Premium Assumptions

A chief problem with a predetermined asset allocation glidepath is that it tacitly assumes a linear reward for risk-bearing.[22] If there's a lesson from the Lost Decade of the 2000s, it is that risk-taking is most certainly not linearly rewarded. The S&P 500 Index offered a negative risk premium at the peak of the tech bubble, so there was simply no way that, with a 1% dividend yield,

EXHIBIT 7

Sharpe Ratio and Real Annuity Ratio, Glidepath Strategies vs. Static Allocations, January 2000–December 2012



Source: Research Affiliates, based upon data from Morningstar.

equities could deliver long-term excess returns above bonds anywhere near their historical norms, if any at all.[23] Likewise, many pro-cyclical assets had bottom-decile yields in mid-2007, right before the global financial crisis. Some remain in the bottom decile or quintile even now, in mid-2013. Why does this matter? The mechanistic nature of simplistic TDFs leads to "static" asset allocations *that neither reflect current market conditions or yields, nor adapt opportunistically to the same.*

CAN TARGET-DATE FUNDS BE IMPROVED?

We strongly support the concept of a default solution for retirees, but we think it is time for an evolution in these products, offering a stronger solution to the retirement problem. It is difficult to test one of our most important suggestions—that is, using a broader toolkit—because of the data limitations already noted. Even so, it's possible to achieve improvements in a simple two-pillar, stocks-plus-bonds target-date solution, with some very simple adjustments.[24] It's important to emphasize that we harbor no illusions that we can present a specific replacement for TDFs in this short article. Accordingly, in this section, we merely propose—and test—some relatively simple adjustments to the traditional glidepath-based TDF. We hope that these ideas may help our industry craft more powerful solutions, to better meet investors' needs.

The traditional glidepath approach involves gradually reallocating assets from equities to bonds, in hope of introducing clarity into the portfolio as retirement date approaches. A TDF solution should incorporate some risk management, but are we controlling the right risk? Are we exploring all the options for reducing risk? Rebalancing and de-risking *within* the stock and bond segments of the portfolio garner scant attention.

Consider the natural desire to reduce our volatility in our later years, to lessen the impact of a severe market

downturn on the portfolio at the point in time when a retiree would buy an annuity. One way to reduce risk is to lower the duration of the bond portfolio as we approach retirement. This achieves the goal of reducing portfolio risk. Gradual duration reduction is akin to holding long bonds of unimpeachable credit quality to maturity—we know exactly how much we will get at the end of the day. Similarly, we can reduce risk in the equity allocation by substituting a low-volatility strategy for a cap-weighted index.

Another natural desire among retirees is to increase returns, without taking on more risk, so as to maximize the real value of their retirement nest egg. Eliminating negative alpha (i.e., inefficient asset allocations) is an often-neglected source of additional return. We believe it is possible to access equity returns more efficiently with non–price-weighted strategies, resulting in more return and lower volatility than the cap-weighted indexes typically used in TDFs.[25] These strategies offer the possibility of superior performance, while retaining the benefits of traditional passive investing—broad market exposure, diversification, liquidity, transparency, and low-cost access to equity markets. Using these strategies for the equity portfolio should lead to more efficient equity exposure.

Our simple experiment involves:

- Rebalancing annually to a portfolio with a 50/50 stock/bond asset allocation. Using the balanced approach avoids sensitivity to changing market environments over the life of the portfolio (and start-date/end-date sensitivity), while enjoying some risk-adjusted benefit from rebalancing.
- Move from a static bond duration to a more dynamic, but still simple, rules-based approach in the bond portfolio.
- Move to a more efficient equity portfolio by using "Smart Beta" strategies[26] to improve returns and reduce equity risk.

We view this simple idea as illustrative of what can be done to improve on the TDF design. It involves changing the way we reduce risk, ignoring the rich toolkit of additional markets and asset classes.[27] Further, we recognize that investors have important investment decisions to make at retirement. Those who choose to annuitize will prefer more downside protection in the years leading up to their retirement than others who might choose not to annuitize.[28] For simplicity, we tilt our proposed solution toward those who might annuitize. We readily acknowledge that the target-date end point is not the complete investment horizon, and that retirees face important investment decisions at the point of retirement—particularly given the expected life expectancy for individuals following retirement—but we leave the more complex solutions for another article.

HISTORICAL RESULTS

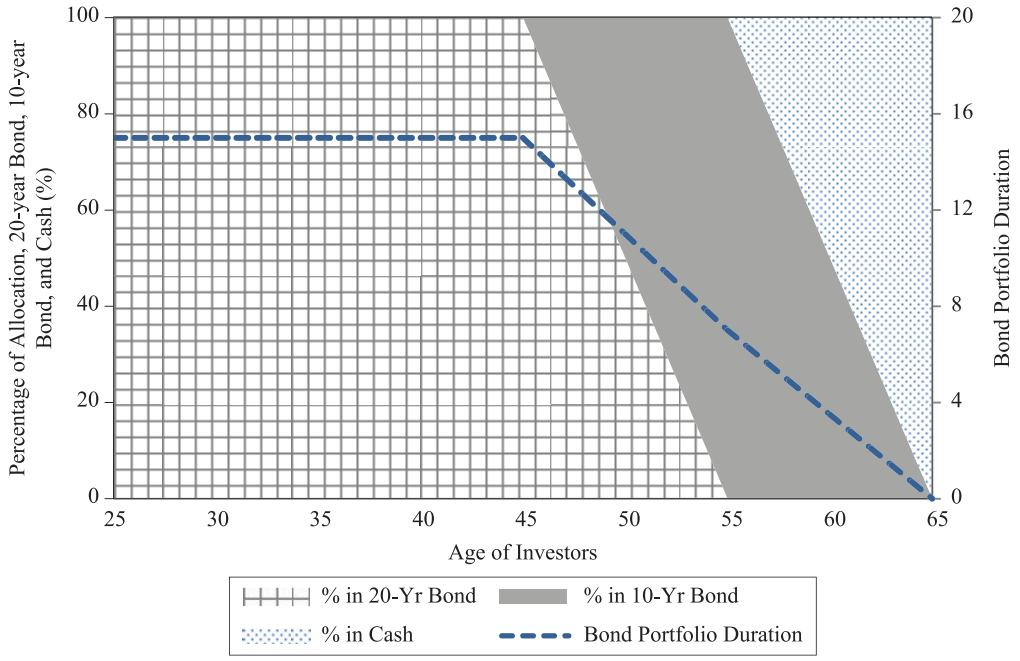
To illustrate how simple changes in the TDF design can improve the performance of the strategies, we extend our analysis to include dynamic duration and Smart Beta solutions. It's important to note that this is an illustrative exercise; we do not propose this as "the answer"! The three extensions are:

1. *Dynamic Duration*. Rather than a static duration solution, we introduce duration reduction by shifting bond holdings twice during the worker's saving life. Early in life, anything less than a 20-year horizon is reasonably meaningless, so we begin with 20-year bonds. Twenty years before retirement, we begin the transition from 20-year bond indexes to 10-year bond indexes, smoothly, one year at a time, and then 10 years before retirement, we transition from 10-year bond indexes to T-bills, also in a linear fashion. Exhibit 8 illustrates the asset mix profile and the associated reduction in duration over time.[29]
2. *Dynamic Smart Beta Equity*. Rather than investing in cap-weighted equity indexes, we introduce more efficient equity solutions with two types of Smart Beta indexes—book-value weighted[30] indexes and low-volatility indexes.[31] The equity portfolio invests in a book-value weighted strategy for the first 21 years, transitioning 5% per year to a low-volatility equity strategy for the last 20 years (the period leading up to retirement). Exhibit 9 illustrates the beta reduction associated with these simple rules.[32]
3. *Duration Reduction and Smart Beta*. Combines options 1 and 2.

We simulate how all six strategies (glidepath, inverse glidepath, static 50/50 balanced, balanced with duration reduction on the bond side, balanced with Smart Beta on the equity side, and balanced with both

EXHIBIT 8

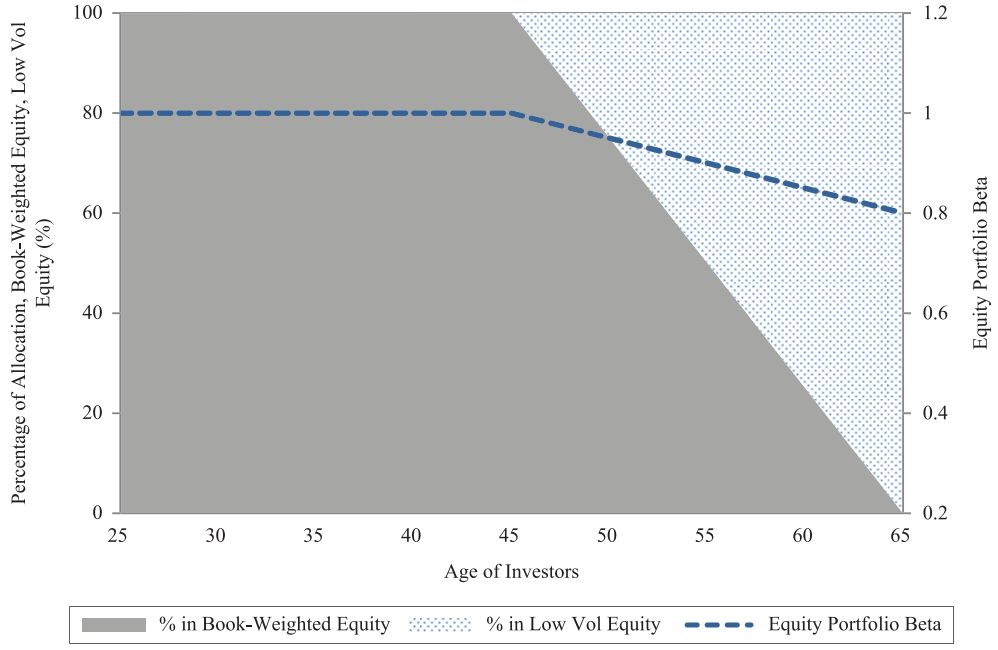
Illustrative Asset Mix in Bond Portfolio and Portfolio Duration



Source: Research Affiliates.

EXHIBIT 9

Illustrative Asset Mix in Equity Portfolio and Portfolio Beta



Source: Research Affiliates.

duration reduction and Smart Beta) would have worked using stock and bond market returns for the 85 years from January 1927 through December 2011. The first worker starts working in 1927 and retires at the end of 1967, and the last worker starts in 1971 and retires at the end of 2011. Each worker is assumed to make a consistent real (inflation-adjusted) $1,000 annual contribution over a 41-year career. This translates into 45 different investment experiences. Portfolios are rebalanced annually, and the results ignore both taxes and transaction costs.[33]

The balanced (static 50/50) portfolio is the benchmark for the new strategies. The balanced static portfolio invests 50% in cap-weighted equity indexes and 50% in 20-year bond indexes. For the Smart Beta strategies, the book-value weighted portfolio consists of the 1,000 U.S. stocks with the highest book value, weighted by book value; the low-volatility strategy comprises the 200 least volatile stocks, selected from the 1,000 largest U.S. companies by market capitalization, weighted by the inverse of volatility.[34] Both Smart Beta strategies are reconstituted and rebalanced annually.

Exhibit 10 summarizes the results for the six strategies. Columns A through C are the three original strategies from Arnott [2012], over this shorter span from 1927; the three alternatives are in Columns D through F. Our analysis focuses on variations to the balanced static alternative, in Column C. Recall that this strategy already tops the classic glidepath strategy, across almost the entire distribution of outcomes. So this is already a tough hurdle to exceed.

Compared to the balanced static strategy (Column C), the dynamic duration strategy (Column D) suggests that, on average, a balanced strategy with duration reduction doesn't lead to higher retirement income; but it does give investors more confidence—less uncertainty—about their likely retirement income. Panel B shows that, on average, the dynamic duration strategy would pay them $7,840 in real terms per year, whereas the balanced static strategy would pay on average $8,220. However, the duration reduction feature does help achieve a much higher minimum value and 10th percentile value of the real annuity in retirement. The cost is, naturally, that we sacrifice some upside; if bond performance is brilliant, we don't garner as much upside.

Panel C shows that, during the final 10 years before retirement, the dynamic duration alternative achieves one of our key goals: less variability in the real annuity. This makes sense. The goal of duration reduction is to provide downside protection, not an upside boost. The average maturity in the bond portfolio of a simple balanced strategy is constant at 20 years, and we assume the weighted average duration of such bond portfolio to be 15 years. For the balanced strategy with duration reduction (Column D), the average duration of the bond portfolio decreases as the retirement year approaches, thereby reducing overall portfolio risk through a simple duration management. Again, we can best visualize such duration reduction effect in Exhibit 8.

The improvements due to a dynamic Smart Beta allocation—starting with book-value weighting and shifting to low-volatility over time—are more impressive. Compared to the balanced static strategy (Column C), the variation with dynamic Smart Beta equity allocation (Column E) gives investors much higher ending retirement wealth and more generous retirement income—across the full range from lowest to highest outcome—with about the same uncertainty (and much less downside risk) in their final 10-year financial well-being. Although the standard deviation for both ending portfolio wealth and ending real annuity is a bit higher for the dynamic Smart Beta strategy, the added volatility appears to affect the upside "risk," and not the downside risk: the 90th percentile estimate is about 20% higher than balanced static option, both in terms of terminal wealth and real annuity value.

Combining both duration reduction and dynamic Smart Beta leads to a better outcome than any of these other strategies: higher upside potential, more effective downside protection, and less uncertainty (Column F) than the balanced static strategy. We can see in Panel A and Panel B that, on average, for investors saving $1,000 per year for 41 years, an investment in the balanced strategy, with dynamic shifts in bond duration and equity volatility rather than in the stock/bond mix, historically delivers higher average ending retirement assets ($139,590 versus $121,820) and higher average retirement annuity ($9,480 versus $8,220, an average gain of 15%) as compared with the static option … which itself beats the classic glidepath formulation!

Comparing the 10th percentile estimates of ending retirement real annuity, shown in Panel B, the enhanced balanced static strategy (Column F) seems to fare much better than balanced static strategy (Column C) against adverse market movements. And the upside possibilities are also much-improved. Finally, these investors would

EXHIBIT 10

A Comparison of Retirement Strategies, 1927–2011

	A	B	C	D	E	F
	Inverse Glidepath	Glidepath	Balanced Static	Balanced Static 50/50 with Different Variation		
	20→80	80→20	50/50	Dynamic Duration	Dynamic Smart Beta Equity	Duration Reduction + Smart Beta
Panel A: Ending Retirement Assets						
Average	$126,400	$116,440	$121,820	$115,160	$146,580	$139,590
Std Dev	$50,240	$45,090	$45,570	$28,980	$53,980	$33,380
Min	$53,040	$49,940	$51,800	$75,110	$63,840	$93,390
10%ile	$63,410	$64,950	$64,800	$79,570	$81,410	$100,250
50%ile	$128,800	$102,920	$111,620	$113,310	$138,580	$129,170
90%ile	$185,870	$177,340	$182,590	$153,720	$222,840	$184,260
Max	$238,660	$211,330	$193,290	$170,240	$260,750	$197,200
90%/10% Ratio	2.93	2.73	2.82	1.93	2.74	1.84
Panel B: Ending Retirement Real Annuity						
Average	$8,570	$7,820	$8,220	$7,840	$9,860	$9,480
Std Dev	$3,330	$2,590	$2,790	$1,830	$3,050	$1,870
Min	$3,920	$3,990	$4,130	$5,140	$4,920	$6,140
10%ile	$4,540	$4,480	$4,520	$5,560	$5,630	$7,160
50%ile	$8,220	$7,230	$7,640	$7,470	$9,190	$9,480
90%ile	$12,870	$11,210	$11,660	$10,230	$13,840	$11,990
Max	$17,990	$12,590	$14,470	$12,830	$14,530	$12,690
90%/10% Ratio	2.83	2.50	2.58	1.84	2.46	1.67
Panel C: Final 10-Year Change in Income						
Average	165%	124%	145%	134%	158%	149%
Std Dev	117%	80%	96%	81%	94%	83%
Min	-5%	2%	2%	6%	9%	31%
10%ile	17%	17%	22%	24%	40%	44%
50%ile	156%	138%	153%	122%	154%	144%
90%ile	316%	220%	262%	245%	291%	266%
Max	407%	255%	315%	297%	323%	379%
90%/10% Ratio	3.57	2.74	2.97	2.79	2.79	2.54

Source: Research Affiliates, based upon data from Schwert, Shiller, Ibbotson, and Bianco.

historically have enjoyed a substantial improvement in the stability of the prospective retirement income (Panel C), and the corresponding ability to better plan on that future income.

These findings should come as no surprise. The gradual reduction in bond portfolio duration keeps the retirement portfolio's exposure to interest rate risk in check. The dynamic allocation in Smart Beta portfolio provides higher yield in the early saving years and helps reduce equity *beta* (risk exposure) as retirement approaches. The ratio between 10th and 90th percentile is 2.97 for those following a simple balanced static strategy, a very large uncertainty about future retirement income; this falls to 2.54 when we incorporate both duration reduction and efficient equity exposure, even as the median (for example, 50th percentile) outcome improves by over 20%. Retiring with 20% more income, and earlier confidence in knowing what that income may be, seems an important step in the right direction.

It bears repetition, because it's so very important: These substantial improvements, both in retirement wealth and in more confidence in estimating the amount of future retirement income, are based on just two intuitive enhancements: 1) adopting systematic rebalancing to a static 50/50 mix, and 2) adjusting the risk profile *within* the equity and bond portfolios as retirement approaches. A more nuanced approach, involving the whole panoply of alternative markets that have become available in the past 20 years would, we believe, provide an even better outcome, but it cannot be tested

back more than 15 to 30 years, due to limited historical data. In addition, even these potential improvements do not take into account the unique circumstances of individual investors. So while these tests only measure the historical efficacy of some naïve, simple improvements in the conventional two-pillar, stocks-plus-bonds TDF model, we hope they will spur additional research and product innovation in this important area.

CONCLUSION

Investment managers should seek to create products that help our clients meet their objectives. We have a high calling: First, to help shape our clients' expectations to better match a plausible future; second, to help our customers to better frame their objectives; and third, to question current approaches whenever the empirical evidence doesn't support our common perceptions. Conventional wisdom isn't easy to overturn. Still, we believe there are substantial opportunities for improving investors' outcomes, in what is likely to be a difficult future, especially as the immense Baby Boom generation retires and begins to transition from accumulating assets to depleting them.

Our simple experiments suggest that the current glidepath-based TDFs offer ample room for improvement. Instead of lowering risk by shifting to bonds, especially when bond yields are plumbing near-record lows and exposing our clients to some very dangerous risks should they revert to historical norms, we can rein in the risks that matter (duration risk and beta) without sacrificing return. Our illustrative strategies are no recipe for replacing the classic glidepath strategies; they merely illustrate how easy it is to improve our clients' prospective retirement income and wealth. A more sophisticated solution might add a whole spectrum of additional asset classes—many offering more yield or higher growth prospects (or both) than the classic glidepath strategy—and could incorporate tactical disciplines, to avoid the pitfalls of mechanistically trading into markets at near-record low yields. These represent avenues for future research, which we invite others to join us in pursuing.

ENDNOTES

The authors would like to thank Bob Greer, John West, and Philip Lawton for their comments and insights on this article.

[1]This has special resonance today, as the real yield on most conventional domestic bonds is negative.

[2]According to Casey Quirk & Associates, a money management consultancy, TDFs alone will swell to $2.6 *trillion* of assets in 2019, from $341 billion in 2010.

[3]See Arnott [2012] for more on "the glidepath illusion." Others have researched the impact of the glidepath assumption as well. See, for example, Basu and Drew [2009].

[4]The use of a fixed rate of annual saving/investing may be controversial, but any chosen rule would be no less so.

[5]See Charlson and Lutton [2012].

[6]See, for example, Chow et al. [2011], Arnott et al. [2013], and Clare et al. [2013a and 2013b].

[7]Not everyone agrees with our views on cap weighting. See, for example, Perold [2007] and Cassidy et al. [2013].

[8]For alternative definition of retirement income risk, see Fan et al. [2013].

[9]See Garland [2005] or Arnott [2004] for a description of the problem.

[10]Dow Jones Global Target Date series are made up of composite indexes covering stocks, bonds, and cash.

[11]We follow an indirect approach to calculate the cost of funding a 20-year real annuity on an annual basis. At each point of time, we set the present value of the annuity equal to $100 in real terms, and we calculate the value of future streams of payments assuming a discount rate that is equal to an estimated real yield of 20-year TIPS. The value of future payments for a 20-year real annuity changes from year to year due to changes in real yields. With the same level of future payments, higher discount rates/real yields on TIPS would lead to low up-front costs for funding the annuity. The year-to-year change of annuity payments therefore reflects the change in cost of funding the annuity.

[12]Despite the fact that equities are more volatile than bonds, the correlation between stock and bond returns is period-dependent and subject to the frequency of measurement, for example, quarterly versus daily.

[13]See Arnott [2009].

[14]We note that most of the product lines offered to 401(k) participants are overwhelmingly dominated by mainstream stock and bond categories; the bias flows through to the target-date offerings. See, for example, Arnott [2010].

[15]See Gorton and Rouwenhorst [2006] and Page et al. [2010].

[16]See Arnott [2009].

[17]The era of investable third-pillar asset classes is much shorter. The first investable commodity index appeared in 1991, with the creation of the S&P GSCI (the "Goldman Sachs Commodity Index"). TIPS joined the marketplace only in the late 1990s.

[18]The DJRR series includes alternative asset classes such as commodities, REITs, and TIPS.

[19]See Arnott [2009] for a description of the broader toolkit; other references are available on www.researchaffiliates.com, under "Fundamentals."

[20]To be sure, the huge bull market in TIPS aids this outcome tremendously. At the beginning of 2000, long-term TIPS offered a yield of 4.3%, indexed to CPI and guaranteed by full faith and credit of the U.S. Treasury. At the end of 2012, the yield was negative almost out to a 20-year maturity, and the longest TIPS offered just 0.4%.

[21]High premiums of TIPS in early years following their introduction were associated with the illiquidity of TIPS at the time.

[22]See West [2010].

[23]Arnott [2000] and Arnott and Ryan [2000] wrote about this situation at the time.

[24]Note, we also favor engaging in tactical asset allocation to trim exposure to markets that are popular and comfortable—the markets do not reward comfort—while boosting exposure to markets that are out of favor, even feared or loathed, but tactical asset allocation is more active than the simple mechanistic, rules-based solution we are focusing on in this article.

[25]We acknowledge that non–price-weighted strategies are relatively new alternatives for investors (except for equal weighting, which has been around for years) and thus may not yet be considered a "mainstream" alternative. We encourage more research to test and validate our claims in this area.

[26]Non-price-weighted "indexes" are now widely described as "Smart Beta"; as a convenient short-hand, we will use "Smart Beta" to reference our use of non-price-weighted strategies, such as book-value-weighted and low-volatility strategies.

[27]We limit our solution to changing the risk within asset classes for simplicity, but we also note that many of the third pillar asset class options do not have a long history.

[28]See Fan, Murray, and Pittman [2013] for alternative suggestions for post-retirement investing.

[29]We assume that 20-year bond indexes have a weighted average duration of 15 years, and 10-year bond indexes have a weighted average duration of 7 years.

[30]Companies' book values are commonly used in academic research as a valuation measure; we obtain historical book value data from the Fama–French website.

[31]Low volatility indexes weight stocks proportional to the inverse of their historical volatility.

[32]In our analysis, we assume the market beta of book-weighted equity indexes equals to 1, and the market beta of low volatility equity equals to 0.8.

[33]These latter assumptions may be more realistic than not. The rebalancing can largely be effected by directing new investments into whichever market has performed worst, and the taxes are deferred—for now—for most categories of pension portfolio.

[34]The volatility measure is the inverse of the standard deviation of daily price returns over the prior five years. For earlier years, when there are less than 1,000 stocks in the universe, we select the 20% least volatile stocks. For the first four years of the simulation where we do not have five full years of daily prices, we use the maximum number of years at each point of time to estimate the stock volatility. For example, our simulation starts in 1927, the volatility estimation for stocks in that year would be using one-year daily price return from January 1926 to December 1926; the volatility estimation for stocks in 1928 would be using two-year daily price return from January 1926 to December 1927; and starting from 1931 going forward, all the volatility estimation would be using data covering the full five-year horizon.

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