VIEWPOINT

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The date debate revisited

Evidence continues to support a flat glide path in retirement

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In the context of target date funds (TDFs), the terminology of "to" and "through" refers to the asset allocation (or glide path) of a TDF after the target retirement date stated in the fund's name has been reached. The glide path of a "to" TDF reaches its minimum allocation to growth assets at the assumed target retirement date (the glide path is static in-retirement). The glide path of a "through" TDF reaches its minimum allocation to growth assets later – the glide path's growth allocation is declining in-retirement. In a prior paper, Russell coined the term "date debate" to describe whether glide paths should be "to" or "through."[i]

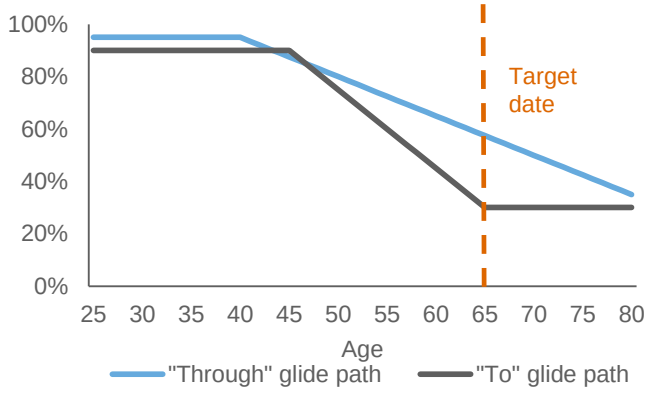
In this paper, we use the terms "to" and "flat" interchangeably, and we treat "through" and "de-risking" the same way.

A majority of TDF providers' offerings have an asset allocation that reaches its minimum growth allocation after its stated target date.[1] Russell takes a different view. Both theory and back testing support a glide path that reaches its minimum growth allocation *at* the target date, as opposed to afterward.

In this paper, we will discuss four topics.

1. Typical ("through") glide path design does not match a participant's exposure to sequence-of-returns risk.
2. A flat glide path makes more sense given both investment and behavioral research.
3. Back-tested results also support the conclusion that flat glide paths are most appropriate in retirement.
4. Common arguments for de-risking in-retirement glide paths do not hold up to scrutiny.

Figure 1: "To" and "through" glide paths



Source: Russell. For illustrative purposes only. Not meant to represent any actual investment.

[i] Cohen,J., Fan, Y., and Gardner, G. (2010, April). "The date debate: Should target date fund glide paths be managed 'to' or 'through' retirement?" *Russell Research*.

1. Typical (“through”) glide path design does not match a participant’s exposure to sequence-of-returns risk

A bad investment experience can do much more damage if occurs at certain critical times than at other, less critical times. Sequence of returns risk (“sequential risk”)[2] is the risk of experiencing an unfavorable order of returns such that bad investment returns happen at a critical time. It exists when there are cash flows into or out of a risky portfolio.[3] Sequential risk affects defined contribution (DC) plan participants since the purpose of a DC program is to accumulate assets via periodic contributions prior to retirement and then periodically withdraw them during retirement.

Sequential risk may not be top of mind for plan sponsors choosing TDF glide path for their plan participants, but understanding it is essential to making an informed choice. In fact, sequential risk explains why many TDF glide paths de-risk prior to the stated retirement date. It also explains why we believe a glide path should not continue to de-risk past the target date.

To expand on this concept, let’s look at what happens to account values over a 20-year period in three hypothetical scenarios (Figure 2). In the first scenario, the period begins with $250,000 in previously accrued savings, and there are no withdrawals and no contributions over the period. In the second scenario, contributions accumulate over the 20 year time horizon, leading up to retirement. The third scenario begins at the start of a 20-year withdrawal or “decumulation” phase. Each panel considers two series of returns with the same annualized average, but the order of returns is reversed. Both return sequences have an annualized arithmetic average return of 7.0% and an annualized standard deviation of 11.0%.

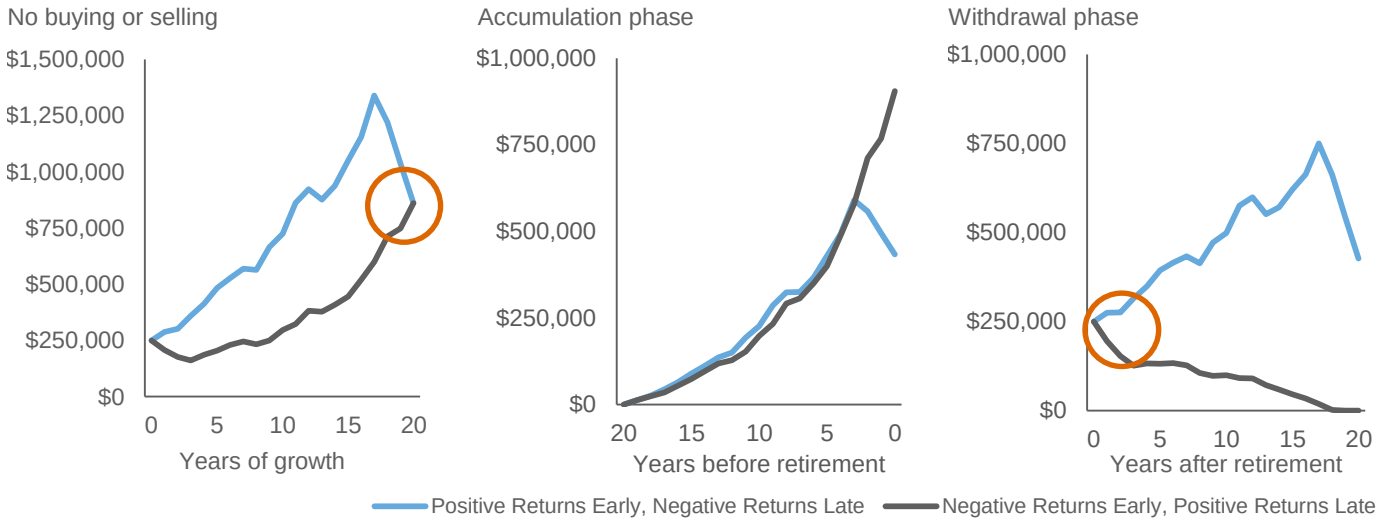
Looking at Figure 2 prompts several observations. First, if there are no contributions and no withdrawals over the period, the sequence of returns would not matter. Whether there are bad returns early or late, the ending value would be the same, given the same returns. Second, bad returns late in the accumulation phase can have a devastating impact on the ending value of wealth. And third, but possibly most important to the topic at hand, bad returns experienced early in the withdrawal phase can lead to retirees’ running out of money or needing to significantly curtail their spending habits in retirement.

From Figure 2 it is clear that sequential risk peaks in the last few years of the accumulation phase and the first few years of the withdrawal phase.

Figure 3 compares a participant’s exposure to sequential risk over time to that participant’s exposure to risk assets via a typical “through” glide path. Participant exposure to sequential risk can be mitigated via asset allocation. As sequential risk increases, the riskiness of the asset allocation should decrease to minimize the influence of returns near the target date.

In fact, this is what all observed TDFs in the market do in the accumulation phase, whether they are “to” or “through.” The difference occurs when one gets to the withdrawal

Figure 2: Impact of sequential risk on account value: no money in or out; contribution phase; withdrawal phase

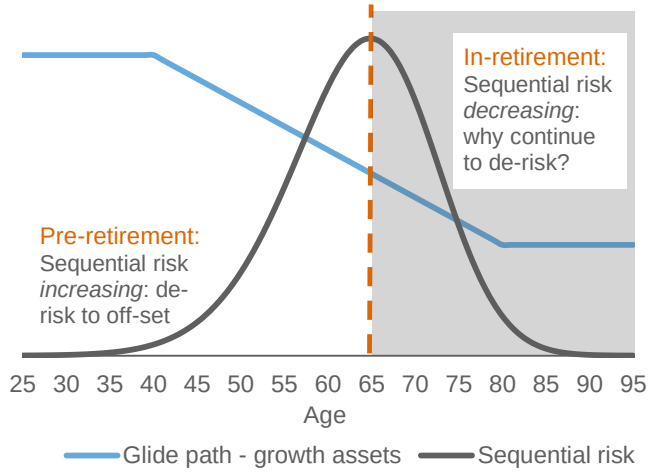


Source: Russell. For illustrative purposes only. The left panel shows the growth of a $250,000 portfolio over 20 years, the middle panel shows the growth of a series of 20 yearly pre-retirement contributions and the right panel shows the growth of a portfolio with a $250,000 account balance subject to 20 yearly withdrawals the same size as the pre-retirement contributions. Contributions (middle) and withdrawals (right) begin at $12,500 in the first year and increase by 3% per year to reflect a cost-of-living adjustment.

phase. As shown in the exhibit, sequential risk peaks in the early years of the withdrawal phase. Yet, if you look just at the in-retirement period, "through" glide paths are at their highest risk allocation at the same point when sequential risk peaks.

Sequential risk and asset allocation risk should move in opposite directions. We believe continuing to de-risk in retirement – as most glide paths do – does not make sense. A flat glide path with a more conservative allocation at the target date – perhaps even a "re-risking" glide path, which starts even more conservatively and becomes more aggressive over time – may help to better reduce sequential risk, relative to a de-risking glide path.[4]

Figure 3: Typical glide path design does not match sequential risk exposure



Source: Russell. For illustrative purposes only. Not meant to represent any actual investment.

2. A flat glide path makes more sense given both investment and behavioral research

To see whether a de-risking glide path in retirement really is harmful to retirement success, it makes sense to test the intuition. Testing examines potential retirement scenarios for a (hypothetical) participant – call her Helen – who takes yearly withdrawals from a retirement portfolio of 4% of its initial value starting at age 65, adjusted for inflation every year. We consider higher withdrawal rates of 5% and 6% as well.

Helen cares about the amount of money she will have left at the end of retirement. The reward and risk metrics are:

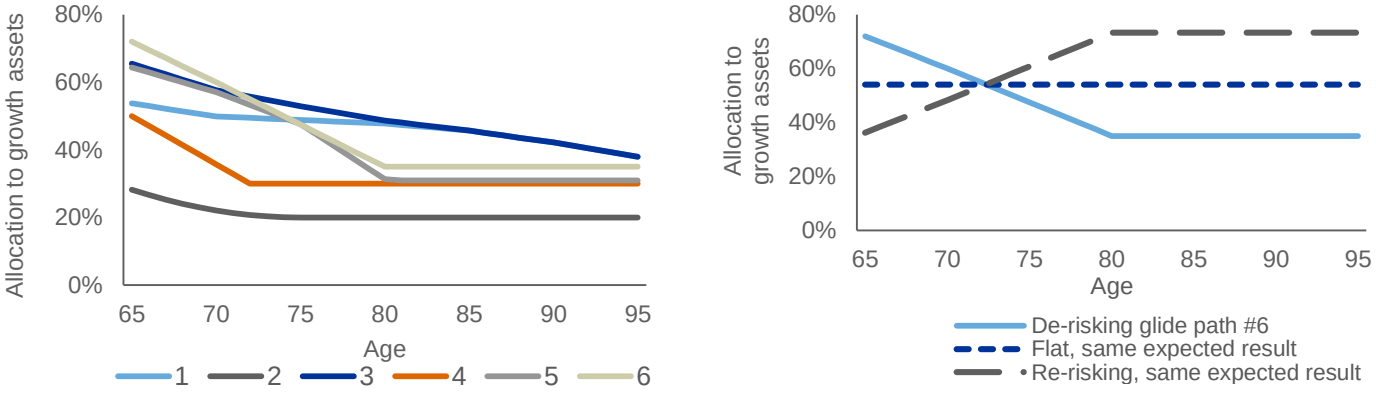
- Reward: The median amount left at the end of retirement (the bequest amount), from a retirement portfolio subject to yearly withdrawals; we will call this the *expected result*. This will be a positive number for most of the withdrawal amounts and glide paths we consider.
- Risk: The 5th percentile bequest amount (which will typically be negative and therefore a shortfall), which we will call the *bad case result*. This will typically be a shortfall for the withdrawal amounts and glide paths we consider: the bigger the negative number, the faster Helen runs out of money.

The details of the bequest calculation approach come from Gardner and Pittman (2013)[5] and are described in the Appendix.

Helen may choose from one of several (hypothetical) TDF glide paths in retirement. There are six groups of glide paths with three variations: de-risking, flat, or "re-risking."

- De-risking glide paths have varying starting allocations to growth assets (like stocks) and degrees of de-risking. They represent the de-risking glide paths available in the DC plan market.
- Flat glide paths are each engineered to have the same expected result as a corresponding de-risking glide path. This makes for easier comparisons between the two types.
- Re-risking glide paths each have the same shape as a corresponding de-risking glide path, but an increasing growth allocation from an initially lower starting point. Again, each re-risking glide path is engineered to have the same expected result as a corresponding de-risking glide path. While this shape may seem counterintuitive, Pfau and Kitces (2013)[6] found that an increasing growth asset glide path in retirement may reduce failure risk of retiree spending plans.[7]

Figure 4: De-risking glide paths (left) and glide path group #6 (right)



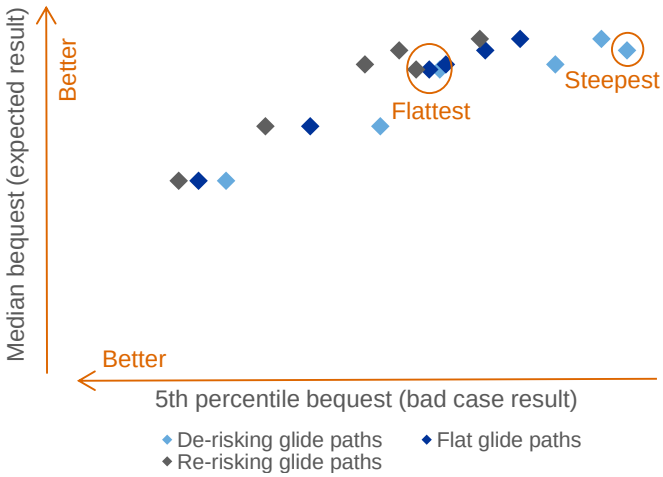
Source: Russell. For illustrative purposes only. Not meant to represent any actual investment.

Figure 4 shows the six de-risking glide paths, along with an example of the corresponding flat and re-risking glide path for one of these glide paths (#6). We leave the balance of glide path information to the Appendix.[8]

Forward-looking testing of Helen's case considers 2,000 different simulated paths of investment returns and inflation. The forward-looking return assumptions are provided in the Appendix.[9]

Figure 5 plots, in a standard risk/reward chart, Helen's expected result (potential amount remaining) on the vertical axis and her bad-case result (potential shortfall) on the horizontal axis for glide paths under the 4% yearly withdrawal scenario. The bad-case values are reversed, so that worse results are out to the right: up and to the left are best.

Figure 5: Helen's case: forward-looking, 4% initial withdrawal



Source: Russell. For illustrative purposes only. Not meant to represent any actual investment.

To varying degrees, all of the re-risking glide paths fall to the left of the de-risking glide paths, indicating that the re-risking glide paths give Helen the same expected outcome while softening the severity of the bad case. Results are consistent with the intuition that the in-retirement glide path should be the opposite of the pre-retirement glide path. The re-risking glide paths mitigate sequential risk by starting retirement at their most conservative allocation and then becoming more aggressive as sequential risk diminishes.

The flat glide paths also improve the bad-case result relative to the de-risking glide paths. Intuitively, it is not surprising that the flat glide paths' bad-case results fall between those of the sloping glide paths. That a flat glide path offers some, but not all, of the investment benefit of a re-risking glide path is consistent with the sequential risk intuition and the Pfau and Kitces findings.[10]

Numerical results for all withdrawal scenarios (4%, 5% and 6%) are left to the Appendix. Both flat and re-risking glide paths maintain their dominance over de-risking glide paths, even with higher withdrawal rates.

Another way to test the intuition on de-risking glide paths is to see whether the glide paths that de-risk the least in retirement generate the best results relative to their corresponding flat and re-risking glide paths. In Figure 5, we circled the flattest (least de-risking) and steepest (most de-risking) glide paths, as defined by the difference between the age 65 growth allocation and the age 80 growth allocation. Look at how far to the right of its corresponding flat glide path each of the de-risking glide paths lies. The flattest holds up best relative to the alternatives, while the steepest holds up worst.

While from an investment standpoint, both flat and re-risking glide paths improve upon the conventional de-risking glide path, we must consider whether participant behavior affects this assessment. If the conventional wisdom that retirees become more risk-averse with age is correct, then there is room for doubt as to the true efficacy of re-risking in-retirement glide paths. Research on risk tolerance brings into question whether retirees will avoid "panic selling" – i.e., stay committed to a risky portfolio – following a major market decline.[11] This tendency may increase for older retirees.[12]

For these behavioral reasons, this paper does not advocate a re-risking glide path. While it may be best in a quantitative simulation, it would not be prudent to assume that retirees would stick with an aggressive allocation when faced with market declines.

Yet the de-risking glide path is not exempt from criticism on behavioral grounds. With a relatively aggressive allocation at the retirement date, it is most vulnerable to participants' panic-selling tendencies during the critical early years of retirement. Locking in bad returns early in retirement greatly increases the likelihood of needing to cut back spending later in retirement. As shown in Figure 2, for retirees planning periodic withdrawals, the returns experienced by older retirees are much less impactful than those experienced by younger retirees. While younger retirees may be less likely to bail out of a risky portfolio, if they do, the consequences can potentially be much more harmful.

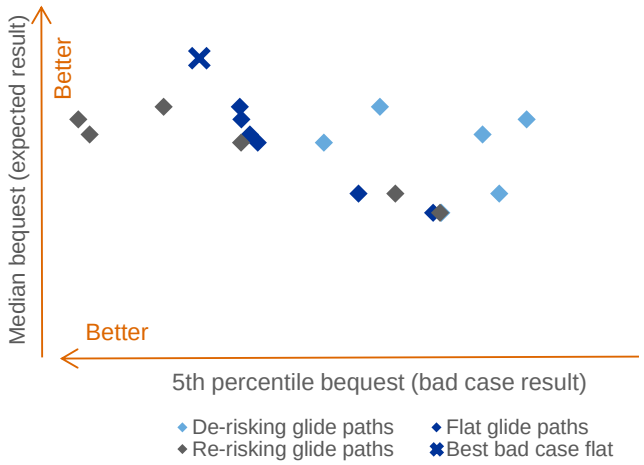
We believe a flat glide path in retirement, with a lower starting growth allocation than a de-risking glide path and a lower ending growth allocation than a re-risking glide path (as in Figure 4), strikes a nice balance between investment and behavioral considerations relative to the other options. It avoids the uncompensated sequential risk taken by de-risking glide paths and may decrease the likelihood of panic selling during the crucial early retirement years. Relative to a re-risking glide path, it captures much of the investment benefit from avoiding sequential risk and mitigates the behavioral risk of older retirees bailing out following market declines.

3. Back-tested results also support the conclusion that flat glide paths are most appropriate in retirement

Simulated results, like those presented so far, can be dismissed by skeptics as being driven by assumption choices. To counter this perspective, additional testing of Helen's case looks at back-tested results of the same glide paths with historical U.S. investment returns. We use the Ibbotson record of stock returns (S&P 500), bond returns (Barclay's Aggregate bond index) and inflation (U.S. CPI) from 1926 through 2014. The setup for back-testing is similar to the forward-looking testing – e.g., we generated the flat and de-risking glide paths in the same way – but it necessarily requires some tweaks; details of the back test are in the Appendix.

Figure 6 has the back-tested results of Helen's 4% withdrawal case. The chart setup is exactly the same as the forward-looking chart.

Figure 6: Helen's case: historical back test (1926–2014), 4% initial withdrawal



Source: Russell. For illustrative purposes only. Not meant to represent any actual investment.

The intuition that de-risking glide paths do not mitigate Helen's sequential risk would also have been true historically. Once more, testing indicates that for each de-risking glide path, Helen can choose a corresponding flat glide path or de-risking glide path that mitigates her bad-case result. The re-risking glide paths, represented by gray diamonds, tend to be superior from a risk/reward perspective to the flat glide paths, which tend to be superior to the de-risking glide paths. Numerical results for all withdrawal scenarios (4%, 5% and 6%) are left to the Appendix. Results for the other withdrawal rates have similar relative results.

Compared to the forward-looking results, the historical back tests support very aggressive glide paths. This is reflected in Figure 6. Look at the dark blue diamonds, where the set of flat glide paths does not offer a typical reward/risk trade-off. Instead, historically, a better expected result is associated with a better bad-case result (compare this to the set of flat glide paths in Figure 5, where a better expected result comes with a worse bad-case result). In the 4% withdrawal case, among flat glide paths, a 75% growth asset allocation – indicated by the dark blue X – maximized the value of Helen's bad-case bequest. More conservative allocations, like the dark blue diamonds, would have made worse both the bad-case and the expected bequest values. This is not surprising, given the history of the U.S. capital markets, which were very fruitful during the 20th century, particularly for stocks. Average inflation-adjusted returns were 8.9% for stocks and 2.8% for bonds during the back-test period (a 6% difference), compared to just 5.8% and 1.8% in forward-looking modeling (a 4% difference).

Nearly all TDF glide paths – not just the six shown above – are positioned conservatively, relative to what would have worked best historically, but this does not indicate that the industry is foolish. As cited above, the risk/reward trade-off of stocks versus bonds is projected to be considerably different going forward, making feasible more bond-heavy allocations viable.[13] Additionally, consider the behavior of many investors during times of panic, discussed briefly earlier. Even if the more aggressive allocations lead to better results, typical investors have tended to sell during times of market stress, locking in their bad returns, and may not get back into the market in time to take advantage of a rebound. This result would be an even worse outcome than the strategic de-risking in retirement this paper argues against.

4. Common arguments for de-risking in-retirement glide paths do not hold up to scrutiny

We have presented our reasoning and evidence against a de-risking, or "through," glide path in retirement, and in this section we rebut several common arguments made for it.

Myth: If participants stay in the plan in retirement, they need a "through" glide path to get them through retirement. If they leave the plan at retirement, they need a "to" glide path.

February 2013 Department of Labor guidance[14] may indicate that "to" funds are designed for employees who want to cash out of the plan when they retire, while "through" funds are for employees who wish to leave their savings in the plan and withdraw them periodically over several years.

In our opinion this reasoning does not hold up to scrutiny. Rather, a flat glide path is more prudent than a de-risking one, regardless of what participants do with their savings. In broad strokes, participants may do one of three things:

1. Spend assets down very quickly ("buy a boat"), in which case, asset allocation does not matter.
2. Withdraw assets periodically. For participants planning periodic withdrawals, this paper has shown, with the concept of sequential risk, the benefits of a flat glide

path relative to a de-risking glide path. It is not apparent why the glide path strategy should depend on whether participants leave assets in the plan or roll them out. In-plan and out-of-plan assets are fungible: one can be substituted for the other as easily as a dollar bill can be substituted for four quarters.

3. Leave assets in the plan as long as possible. Participants making this decision may face a series of periodic withdrawals – i.e., required minimum distribution (RMD) rules beginning at age 70½ – preceded by several years of no withdrawals. A flat glide path reduces sequential risk for the years when the RMD rule is in effect. In the years of no withdrawals, before age 70½, the participant is investing a lump sum. We previously noted that sequential risk arises from contributions and withdrawals. It does not impact the ultimate size of a lump-sum investment, as shown in the left panel of Figure 2. A de-risking glide path amounts to a bet that the first few years of the pre-RMD period will confer better growth asset returns than the last few years. This is impossible to predict.

Myth: Participants may work in retirement. Therefore, the glide path should continue to de-risk.

Some participants may continue to work their current jobs, while others may take new positions, perhaps with reduced time commitments. Working after age 65 has become increasingly common: in 2010, 16% of the U.S. 65-plus population was working, compared to 12% in 1990.[15] If there is a belief that typical participants will continue to contribute to the plan after the assumed target date, then a de-risking glide path is appropriate, just as it is for all pre-retirees. But, as the vehicle is designed, a participant who is planning to delay retirement should move into an appropriate TDF – one with a target date that is around the participant's anticipated retirement date. Plan sponsors can help by communicating this to participants. Alternatively, if participants work past the assumed retirement date but cease making contributions to the plan, they are now investing a lump sum. As described, sequential risk arises from contributions and withdrawals – there is no clear reason for the glide path to slope without either. A flat glide path should be the default approach in this case. In Russell's view, while we advocate for a flat glide path that is often referred to as a "to" approach, we believe it is the best way to help participants "through" retirement within a TDF.

Myth: "Through" glide paths address longevity risk by maintaining a high allocation to growth assets.

To summarize this common argument: TDF glide paths must have a relatively high growth asset allocation so that participants can address "longevity risk," i.e., generate sufficient income to support spending during a retirement that may last 30 years or more.[16] Plan sponsors who want to help address participant longevity risk should not take this position at face value. It confuses longevity risk with retirees' desire to spend more than they can afford.

Longevity risk is simply the risk of outliving one's retirement assets. The most certain means for a retiree to mitigate longevity risk is to de-risk her portfolio into a life annuity[17] (whether fixed or variable) to create a level of assurance that there will be a consistent stream of lifetime income. To say more aggressive allocations decrease longevity risk is factually misleading.

However, given the low interest rates at the time of this writing, some allocation to growth assets may be necessary to support desired spending levels. Indeed, nearly all TDF glide paths maintain an allocation to growth assets. So it is not so much that "through" glide paths decrease longevity risk, as it is that retirees cannot support the spending they want with a de-risked portfolio. Aggressive allocations improve the chance that retirees can sustain relatively high portfolio withdrawals.[18]

Yet with an aggressive portfolio and spending plan there are considerable risks. This strategy increases the chance that a retiree will need to reduce her spending in the future to avoid running out of money. Retirees understandably dislike forced spending decreases and strongly desire to avoid poverty.[19] Additionally, aggressive asset allocations increase the chance of panic selling, which may undermine the benefits of the strategy. It is our opinion that these risks are best addressed with the combination of a sustainable spending plan and a conservatively allocated portfolio.

Ultimately, the decision between a conservative or aggressive allocation in retirement is a question of risk tolerance. Neither is clearly better, and neither fully "addresses" longevity risk (a life annuity does that).

Myth: "To" glide paths de-risk too quickly in the pre-retirement phase (to get to a conservative allocation at the target date) and may "lock in" poor returns. "Through" glide paths lessen this risk.

According to this position,[20] in order to get to a conservative allocation at the target date, "to" glide paths need to have a steep (quickly de-risking) glide path that risks locking in negative market returns. On the other hand, "through" glide paths de-risk less quickly and diminish this risk.

There is a crucial difference between de-risking in the accumulation phase and doing so in the withdrawal phase: contributions can help make up for losses in the first, but withdrawals aggravate losses in the second. In the accumulation phase, participants still have future contributions to make up for losses and perhaps "buy low" following a market downturn. The opposite takes place in retirement. A de-risking in-retirement glide path with a higher initial growth allocation increases participants' exposure to potential poor market returns early in retirement and reduces their ability to make up for poor returns in future years, especially if participants are selling assets.

Justifying a "through" glide path with the "'to' is too steep" argument is a puzzling position. It contends that excessive pre-retirement de-risking may lock in losses while simultaneously advocating for a de-risking glide path in retirement. Yet an in-retirement de-risking glide path is more likely to lock in losses, given withdrawals.

Conclusions

The question of whether TDF glide paths are best managed with a "to" or a "through" approach has become prominent in the DC industry, gaining the attention of several TDF managers and the Department of Labor. This is heartening, given TDFs' growing share of DC plan investments and the fact that thousands of baby boomers are retiring every day. The battle for intellectual authority over the management of TDF assets in retirement will have increasingly high stakes.

Most TDF money is managed with a "through," or de-risking, approach in retirement. This paper has strongly questioned whether this approach is best for retirees. The greater sequential risk created with in-retirement de-risking glide paths makes retirees' standards of living more vulnerable to market downturns. The opposite approach – a re-risking glide path – appears preferable from an investment standpoint, yet it does not mesh well with typical retiree behavior. We believe a flat glide path represents a happy middle ground. It may provide the same level of expected retirement spending as a de-risking glide path, but with less downside risk. It may reduce the risk of retiree behavior undermining its efficacy, as compared to a re-risking glide path or even, perhaps, a de-risking glide path. Common arguments made in favor of de-risking glide paths are potentially misleading and should be considered carefully.

[1] Per Morningstar: "Fidelity, Vanguard, and T. Rowe Price all use 'through' glide paths, thus putting the vast majority of the target-date industry's assets into that class of glide path. The scales are somewhat more balanced across all series, with 21 choosing 'to' glide paths and 30 using 'through' ones." See Morningstar's 2014 Target Date Series Research Paper, available at Morningstar.com.

[2] Collie and Smith. "Sequential Risk: When it comes to investment returns in defined contribution plans, 'when' can be almost as important as 'how much.' *Russell Research*. February 2008.

[3] If either assumption (buying/selling of assets or a risky portfolio) is false, the sequence of returns would not impact outcomes. If no assets are bought or sold, any order of returns will result in the same final portfolio value. If a retiree completely de-risks her portfolio (e.g., with purchase of bonds held to maturity or a fixed annuity) she would not have her spending impacted by the order of portfolio returns.

[4] There is one caveat to this discussion: sequence risk becomes less of an issue if retirees are willing to adjust their withdrawals in line with experienced portfolio returns. For instance, retirees who withdraw a certain percentage of their portfolio's current value – as opposed to its initial value – can reduce their cash outflow.

[5] Gardner and Pittman 2013. "Measuring the Risk of Running Out of Money in Retirement." *Journal of Financial Planning*, December 2013.

[6] Pfau and Kitces. "Reducing Retirement Risk with a Rising Equity Glide-Path." September 2013. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2324930.

[7] For completeness, we must acknowledge another thread of research that finds support for a de-risking glide path. See Blanchett, David. "Revisiting the Optimal Distribution Glide Path." Journal of Financial Planning, February 2015. As of this writing, the authors of these two papers are comparing notes to understand differences in results.

[8] To be clear, the level of growth assets (though not the shape) of the flat and re-risking glide paths may change somewhat for different withdrawal rates. This way, each has the same expected result as its corresponding de-risking glide path for a given withdrawal rate.

[9] Note that the assumed returns are time-varying, consistent with low interest rates, which (as of this writing) are anticipated to rise. This assumption leads to low bond returns for the first several years of retirement, which would penalize re-risking glide paths that have a higher initial allocation to bonds.

[10] The flat and re-risking glide paths, with greater initial bond allocations than the de-risking glide paths, offer projected improvement in the bad case result, even though, as mentioned, initial bond returns are assumed to be low. The Blanchett paper cited in the footnotes is similarly grounded in current low interest rates and expects them to increase in the future. Yet the directionality of this paper's finding – that flat or re-risking in retirement is better from an investment standpoint – differs.

[11] Guillemette, Finke, and Gilliam. "Risk Tolerance Questions to Best Determine Client Portfolio Allocation Preferences." May 2012. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2088998.

[12] Finke, Howe and Huston. "Old Age and the Decline in Financial Literacy." August 2011. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1948627.

[13] Similarly, when the premium of growth assets over fixed income increases, more growth-heavy allocations become feasible. An increase in the estimated forward-looking premium was a major reason why Russell increased the growth allocation of its "in retirement" TDFs from 32% to 37% last year.

[14] "Target Date Retirement Funds – Tips for ERISA Plan Fiduciaries." February 2013. Available at http://www.dol.gov/ebsa/pdf/fsTDF.pdf

[15] Kromer, Braedyn, and David Howard. "Labor Force Participation and Work Status of People 65 Years and Older: American Community Survey Briefs." U.S. Census Bureau. January 2013. Available at https://www.census.gov/prod/2013pubs/acsbr11-09.pdf

[16] Fullmer, Richard K., and James A. Tzitzouris. "Evaluation of Target-Date Glide Paths within Defined Contribution Plans." September 2013. Available at http://ssrn.com/abstract_id=2338481.

[17] Guarantees are based upon the claims-paying ability of the issuing insurance company.

[18] Gardner and Pittman. "Retirement sustainability for defined contribution plan participants." *Russell Research*, May 2011.

[19] "Understanding the Accidental Investor: Baby Boomers on Retirement." Financial Engines 2011 report. Available at http://corp.financialengines.com/employers/Accidental_Investor_April2011.pdf.

[20] Iantchev, Emil, Mathew R. Jensen and Sarah O'Toole. "Glide Path Caution! A Steep Slope Could Derail Retirement Income Success." February 2015. Available at https://communications.fidelity.com/common/pdf/GlidePathCautionASteepSlopeCouldDerailRetirementIncomeSuccess.pdf.

Appendix

Explanation of Gardner and Pittman (2013) bequest metric

Gardner and Pittman observed that metrics assessing the sustainability of a retirement plan need not be based on an arbitrarily selected time horizon, e.g., 30 years. Rather, each year in retirement may be weighted according to the likelihood that the retiree lives to that year. Doing so provides a more accurate representation of the true risk to retirees: running out of money before life's end.

The calculations in our paper closely follow the Gardner and Pittman approach. The calculations consist of two elements: average ending wealth and average cumulative shortfall.

- Average ending wealth calculation: Each year in a given retirement scenario has an associated portfolio balance. We calculate the size of this balance after the annual withdrawal, which is assumed to occur at the beginning of each period. If the balance is zero in one period, then it is zero in all subsequent periods. Finally, we calculate a mortality-weighted average ending wealth by weighting each period's balance according to the likelihood of the retiree dying in that year (these probabilities sum to 100%).
- Average cumulative shortfall calculation: Each year in a given retirement scenario, we compare the size of the planned withdrawal to the remaining value of the retirement portfolio. If the planned withdrawal exceeds available assets, the amount of the difference is a shortfall. In each subsequent year, the entire size of the planned withdrawal is a shortfall. Next, we weight each year's shortfall according to the likelihood the retiree is alive. So, a $10,000 shortfall at age 100 receives a lesser weight than the same shortfall at age 90. Finally, we add up the weighted shortfall values.

We use the Society of Actuaries' Annuity 2000 Basic Table for Females as our mortality assumption.

The bequest values we cite in the body are taken from the distribution of the difference between the average ending wealth and the average cumulative shortfall across 2,000 investment scenarios. Gardner and Pittman call it surplus; we call it bequest.

Table 1: Glide paths and results for forward-looking case

Results based on a notional starting account balance of $250,000.

GLIDE PATHS			GROWTH ALLOCATION BY AGE							RESULTS		
Shape	Withdrawal rate	Group	65	70	75	80	85	90	95	Expected (median) result	Bad case (5th percentile) result	Improvement over de-risking in bad case
De-risking	4%	1	54%	50%	49%	48%	46%	42%	38%	$111,391	($25,797)	---
		2	28%	22%	20%	20%	20%	20%	20%	$67,414	($12,369)	---
		3	66%	58%	53%	49%	46%	42%	38%	$123,380	($35,959)	---
		4	50%	36%	30%	30%	30%	30%	30%	$88,991	($22,051)	---
		5	64%	57%	48%	31%	31%	31%	31%	$113,351	($33,059)	---
		6	72%	60%	48%	35%	35%	35%	35%	$118,902	($37,560)	---
	5%	1	54%	50%	49%	48%	46%	42%	38%	$26,743	($89,588)	---
		2	28%	22%	20%	20%	20%	20%	20%	($6,809)	($72,279)	---
		3	66%	58%	53%	49%	46%	42%	38%	$35,969	($96,556)	---
		4	50%	36%	30%	30%	30%	30%	30%	$10,695	($82,125)	---
		5	64%	57%	48%	31%	31%	31%	31%	$29,395	($95,699)	---
		6	72%	60%	48%	35%	35%	35%	35%	$34,953	($101,142)	---
	6%	1	54%	50%	49%	48%	46%	42%	38%	($48,991)	($147,400)	---
		2	28%	22%	20%	20%	20%	20%	20%	($75,610)	($132,798)	---
		3	66%	58%	53%	49%	46%	42%	38%	($41,504)	($155,691)	---
		4	50%	36%	30%	30%	30%	30%	30%	($60,939)	($142,932)	---
		5	64%	57%	48%	31%	31%	31%	31%	($44,629)	($154,725)	---
		6	72%	60%	48%	35%	35%	35%	35%	($41,289)	($160,155)	---
Flat	4%	1	50%	50%	50%	50%	50%	50%	50%	$111,391	($25,136)	$661

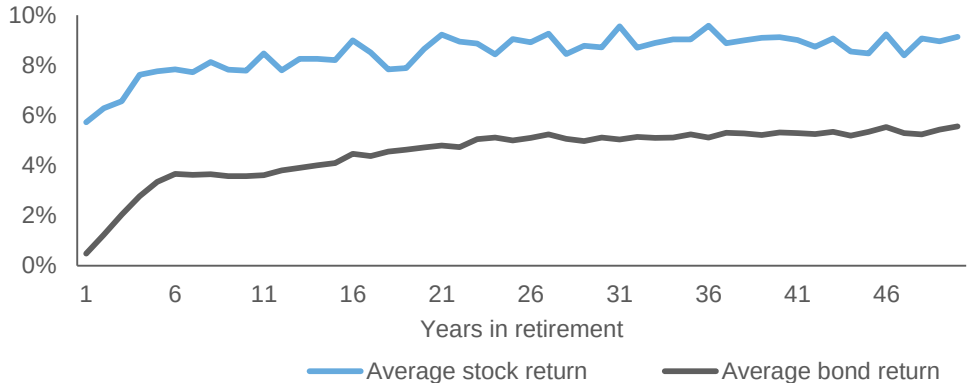
		2	23%	23%	23%	23%	23%	23%	23%	$67,414	($10,626)	$1,744
		3	57%	57%	57%	57%	57%	57%	57%	$123,380	($30,846)	$5,114
		4	37%	37%	37%	37%	37%	37%	37%	$88,991	($17,645)	$4,406
		5	51%	51%	51%	51%	51%	51%	51%	$113,351	($26,189)	$6,869
		6	54%	54%	54%	54%	54%	54%	54%	$118,902	($28,650)	$8,911
	5%	**1**	50%	50%	50%	50%	50%	50%	50%	$26,743	($88,425)	$1,162
		2	24%	24%	24%	24%	24%	24%	24%	($6,809)	($71,303)	$976
		3	58%	58%	58%	58%	58%	58%	58%	$35,969	($94,064)	$2,492
		4	38%	38%	38%	38%	38%	38%	38%	$10,695	($78,374)	$3,751
		5	53%	53%	53%	53%	53%	53%	53%	$29,395	($90,669)	$5,031
		6	57%	57%	57%	57%	57%	57%	57%	$34,953	($93,316)	$7,826
	6%	**1**	51%	51%	51%	51%	51%	51%	51%	($48,991)	($147,297)	$103
		2	24%	24%	24%	24%	24%	24%	24%	($75,610)	($131,614)	$1,184
		3	59%	59%	59%	59%	59%	59%	59%	($41,504)	($153,711)	$1,980
		4	38%	38%	38%	38%	38%	38%	38%	($60,939)	($139,048)	$3,884
		5	57%	57%	57%	57%	57%	57%	57%	($44,629)	($151,393)	$3,333
		6	60%	60%	60%	60%	60%	60%	60%	($41,289)	($153,879)	$6,275
Re-risking	**4%**	**1**	46%	50%	51%	52%	54%	58%	62%	$111,392	($24,305)	$1,492
		2	18%	24%	26%	26%	26%	26%	26%	$67,414	($9,389)	$2,980
		3	47%	55%	59%	64%	67%	70%	74%	$123,379	($28,305)	$7,655
		4	23%	38%	44%	44%	44%	44%	44%	$88,992	($14,845)	$7,207
		5	38%	45%	54%	71%	71%	71%	71%	$113,352	($21,095)	$11,964
		6	36%	48%	61%	73%	73%	73%	73%	$118,903	($23,247)	$14,313
	5%	**1**	47%	51%	52%	53%	55%	59%	63%	$26,742	($87,591)	$1,997
		2	19%	25%	27%	27%	27%	27%	27%	($6,808)	($70,245)	$2,035
		3	51%	59%	64%	68%	71%	74%	79%	$35,968	($91,191)	$5,365
		4	26%	41%	46%	46%	46%	46%	46%	$10,694	($77,238)	$4,888
		5	43%	50%	60%	76%	76%	76%	76%	$29,396	($85,450)	$10,249
		6	43%	55%	68%	80%	80%	80%	80%	$34,952	($87,932)	$13,210
	6%	**1**	49%	53%	54%	55%	57%	61%	65%	($48,992)	($147,457)	($57)
		2	20%	26%	28%	28%	28%	28%	28%	($75,610)	($130,739)	$2,059
		3	55%	63%	67%	72%	75%	78%	82%	($41,505)	($154,276)	$1,415
		4	28%	42%	48%	48%	48%	48%	48%	($60,939)	($136,424)	$6,507
		5	48%	55%	65%	81%	81%	81%	81%	($44,629)	($149,096)	$5,629
		6	50%	62%	75%	87%	87%	87%	87%	($41,288)	($152,345)	$7,809

Table 2: Forward-looking statistics for Figures 4 and 5

NOMINAL RETURNS	AVERAGE RETURN	VOLATILITY	CORRELATIONS			
			U.S. Stocks	Non-U.S. developed markets stocks	Bonds	Inflation
U.S. stocks	8.3%	18.2%	1			
Non-U.S. developed markets stocks	8.8%	20.5%	0.89	1		
Bonds	4.5%	5.6%	0.40	0.34	1	
Inflation	2.7%	2.7%	0.06	0.02	0.15	1

The growth asset segment of the portfolio in Figures 1, 2 and 3 is comprised of a 67%/33% mix of U.S. and non-U.S. stocks. The annual returns of the asset classes are non-normal and time-varying, consistent with observed market behavior. In particular, interest rates are assumed to rise over the first several years of the simulation. Statistics shown represent the average mean-variance statistics for each period. Figure 8, below, shows the average return of the 67%/33% blend of stocks and bonds for each year in the simulation.

Figure 8: Year-by-year average returns for forward-looking case



Back test assumptions

- Investment returns. We use the Ibbotson record of stock returns (S&P 500), bond returns (Barclay's Aggregate bond index) and inflation (U.S. CPI) from 1926 through 2014. This constitutes 70 rolling periods of returns (70 retiree scenarios), the first beginning in 1926 and the last in 1995. The scenarios are all at least 20 years in length. While there are records of returns from other countries (notably the Dimson, Marsh and Staunton data), international assets were not feasible options for most U.S.-domiciled investors until fairly late in the test period.
- Mortality assumptions. Rather than use the Annuity 2000 table, we used estimated realized mortality for females from the Social Security Administration.[ii] Life expectancy was significantly lower overall, relative to the Annuity 2000 table, and assumptions have appreciated significantly over time. While only 17% of the 65-year-old female retirees in 1926 lived on to age 85, almost half of the 65-year-old female retirees in 1995 are expected to do so.
- Small technical difference from forward-looking case. Since we do not have enough years to simulate a full retirement in the later test periods, we developed a workaround to calculate our bequest metric. After the last year of a test period (i.e. after 2014), we compare back tested wealth to the cost of a fixed life annuity that would provide the desired spending for life. To price the annuity, the discount rate is the real yield on 10-year TIPS as of January 2, 2015, and the mortality assumptions are, again, from the Society of Actuaries' Annuity 2000 Basic Table for Females.

[ii] Social Security historical death probabilities data, 1900–2010. Available at http://www.ssa.gov/oact/HistEst/DeathProbabilities2014.html

Table 3: Glide paths and results for historical case

Results based on a notional starting account balance of $250,000.

GLIDE PATHS			GROWTH ALLOCATION BY AGE							RESULTS - REAL $		
Shape	Withdrawal rate	Group	65	70	75	80	85	90	95	Expected (median) result	Bad case (5th percentile) result	Improvement over de-risking in bad case
De-risking	4%	1	54%	50%	49%	48%	46%	42%	38%	$306,715	$92,178	---
		2	28%	22%	20%	20%	20%	20%	20%	$200,722	$84,392	---
		3	66%	58%	53%	49%	46%	42%	38%	$360,530	$88,445	---
		4	50%	36%	30%	30%	30%	30%	30%	$229,646	$80,550	---
		5	64%	57%	48%	31%	31%	31%	31%	$318,848	$81,642	---
		6	72%	60%	48%	35%	35%	35%	35%	$341,481	$78,720	---
	5%	1	54%	50%	49%	48%	46%	42%	38%	$233,786	$13,090	---
		2	28%	22%	20%	20%	20%	20%	20%	$143,143	$12,147	---
		3	66%	58%	53%	49%	46%	42%	38%	$265,678	$12,546	---
		4	50%	36%	30%	30%	30%	30%	30%	$167,392	$10,683	---
		5	64%	57%	48%	31%	31%	31%	31%	$234,045	$10,470	---
		6	72%	60%	48%	35%	35%	35%	35%	$256,620	$9,068	---
	6%	1	54%	50%	49%	48%	46%	42%	38%	$155,896	($44,582)	---
		2	28%	22%	20%	20%	20%	20%	20%	$92,820	($41,100)	---
		3	66%	58%	53%	49%	46%	42%	38%	$176,677	($46,347)	---
		4	50%	36%	30%	30%	30%	30%	30%	$119,246	($42,431)	---
		5	64%	57%	48%	31%	31%	31%	31%	$163,130	($46,806)	---
		6	72%	60%	48%	35%	35%	35%	35%	$176,291	($47,453)	---
Flat	4%	1	50%	50%	50%	50%	50%	50%	50%	$306,715	$96,548	$4,371
		2	24%	24%	24%	24%	24%	24%	24%	$200,722	$84,927	$534
		3	56%	56%	56%	56%	56%	56%	56%	$360,530	$97,736	$9,291
		4	29%	29%	29%	29%	29%	29%	29%	$229,646	$89,877	$9,327
		5	51%	51%	51%	51%	51%	51%	51%	$318,848	$97,073	$15,431
		6	54%	54%	54%	54%	54%	54%	54%	$341,481	$97,632	$18,911
	5%	1	50%	50%	50%	50%	50%	50%	50%	$233,786	$12,499	($591)
		2	23%	23%	23%	23%	23%	23%	23%	$143,143	$11,940	($207)
		3	57%	57%	57%	57%	57%	57%	57%	$265,678	$12,900	$353
		4	31%	31%	31%	31%	31%	31%	31%	$167,392	$12,371	$1,687
		5	50%	50%	50%	50%	50%	50%	50%	$234,045	$12,501	$2,031
		6	55%	55%	55%	55%	55%	55%	55%	$256,620	$12,840	$3,773
	6%	1	49%	49%	49%	49%	49%	49%	49%	$155,896	($44,387)	$194
		2	24%	24%	24%	24%	24%	24%	24%	$92,820	($41,274)	($174)
		3	54%	54%	54%	54%	54%	54%	54%	$176,677	($45,400)	$947
		4	36%	36%	36%	36%	36%	36%	36%	$119,246	($42,548)	($117)
		5	51%	51%	51%	51%	51%	51%	51%	$163,130	($44,746)	$2,060
		6	54%	54%	54%	54%	54%	54%	54%	$176,291	($45,358)	$2,095

Re-risking	4%	1	46%	50%	51%	52%	54%	57%	61%	$306,714	$97,668	$5,490
		2	20%	26%	28%	28%	28%	28%	28%	$200,720	$84,469	$77
		3	48%	56%	60%	65%	68%	71%	75%	$360,532	$102,787	$14,342
		4	19%	34%	39%	39%	39%	39%	39%	$229,647	$87,429	$6,879
		5	38%	45%	54%	71%	71%	71%	71%	$318,845	$107,707	$26,066
		6	38%	50%	62%	75%	75%	75%	75%	$341,483	$108,447	$29,727
	5%	1	46%	49%	50%	52%	54%	57%	61%	$233,786	$12,189	($901)
		2	19%	25%	27%	27%	27%	27%	27%	$143,143	$13,557	$1,411
		3	47%	55%	59%	64%	67%	70%	74%	$265,680	$13,916	$1,370
		4	19%	34%	40%	40%	40%	40%	40%	$167,393	$15,009	$4,326
		5	36%	43%	52%	69%	69%	69%	69%	$234,044	$16,879	$6,409
		6	37%	49%	61%	74%	74%	74%	74%	$256,621	$18,688	$9,620
	6%	1	46%	50%	51%	52%	54%	57%	62%	$155,894	($44,424)	$157
		2	20%	27%	29%	29%	29%	29%	29%	$92,820	($41,459)	($359)
		3	45%	52%	57%	61%	64%	68%	72%	$176,679	($43,825)	$2,522
		4	23%	37%	43%	43%	43%	43%	43%	$119,248	($41,837)	$594
		5	37%	44%	54%	70%	71%	71%	71%	$163,131	($42,656)	$4,150
		6	36%	48%	60%	73%	73%	73%	73%	$176,290	($41,889)	$5,564

Table 4: Historical statistics for Figure 7, 1926–2014

NOMINAL RETURNS	AVERAGE RETURN	VOLATILITY	CORRELATIONS		
			Stocks	Bonds	Inflation
Stocks	12.1%	20.1%	1		
Bonds	5.7%	5.8%	0.13	1	
Inflation	3.0%	4.1%	-0.01	-0.06	1

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