Reducing Retirement Risk with a Rising Equity Glidepath

by

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Abstract

This study explores the issue of what is an appropriate default equity glidepath for client portfolios during the retirement phase of the lifecycle. We find, surprisingly, that rising equity glidepaths in retirement – where the portfolio starts out conservative and becomes more aggressive through the retirement time horizon – have the potential to actually reduce both the probability of failure and the magnitude of failure for client portfolios. This result may appear counterintuitive from the traditional perspective, which is that equity exposure should decrease throughout retirement as the retiree's time horizon (and life expectancy) shrinks and mortality looms. Yet the conclusion is actually entirely logical when viewed from the perspective of what scenarios cause a client's retirement to "fail" in the first place. In scenarios that threaten retirement sustainability – e.g., an extended period of poor returns in the first half of retirement – a declining equity exposure over time will lead the retiree to have the least in stocks if/when the good returns finally show up in the second half of retirement (assuming the entire retirement period does not experience continuing poor returns). With a rising equity glidepath, the retiree is less exposed to losses when most vulnerable in early retirement and the equity exposure is greater by the time subsequent good returns finally show up. In turn, this helps to sustain greater retirement income over the entire time period. Conversely, using a rising equity glidepath in scenarios where equity returns are good early on, the retiree is so far ahead that their subsequent asset allocation choices do not impact the chances to achieve the original retirement goal.

Introduction

Conventional wisdom suggests an 'age in bonds' style asset allocation strategy over one's lifetime. During the accumulation phase, this can be justified theoretically by considering a household's entire balance sheet including human capital. When young, most clients have saved little and their main asset will be the present value of lifetime future earnings, and they have the capacity to take significant risks with their financial capital (i.e., hold little in bonds because they're young and invest heavily in equities). As their time horizon to retirement shortens, and the buffer value of their human capital declines, so too does their capacity for financial risk and their equity exposure would decline accordingly.

At retirement, human capital falls to zero. However, because of the need to provide for an extended period of retirement income, and to generate growth necessary to maintain inflation-adjusted withdrawals, equity exposure typically does not fall all the way to zero. Nonetheless, even with some equity exposure at the start of retirement, many advisors still justify the concept of a declining equity exposure throughout retirement on the basis that the retiree's time horizon shortens with each passing year. Yet as our research shows, this may not necessarily be best.

Arguably, for someone willing to pay careful attention to the evolving funding status of their retirement (the present value of their remaining assets divided by the present value of their remaining liabilities), asset allocation can be adjusted dynamically by matching assets to liabilities in coordination with the client's risk capacity and risk aversion, rather than just on an arbitrary path. But for those unwilling to take such care, such as users of target date or lifecycle asset allocation funds, or for those whose goals are somewhat more complex in the balancing of current and future, income and legacy goals, what should be the default equity glidepath in the postretirement period?

The purpose of this study is to explore that question, and we find, surprisingly, that rising equity glidepaths in retirement have the potential to actually reduce both the probability of failure and the magnitude of failure for client portfolios. In other words, just as equity exposure can be more beneficial for those who are very young, so too can greater equity exposure in the later years of retirement actually help, especially in those scenarios where returns in the early retirement years are poor and favorable returns – with a healthy amount of equity exposure – are crucial to allow the portfolio to last. In essence, the optimal equity exposure for a portfolio over an accumulation/decumulation lifetime may look less like a slow and steady downward slope, and more like the letter U, in which the stock allocation is the lowest at the point when lifestyle spending goals are most vulnerable to absolute losses in wealth (the retirement transition itself), but is greater in both the earliest years and also the latest.

Literature Review

There is a deep literature studying what retirees may treat as a sustainable withdrawal rate from a portfolio of volatile assets over a long retirement period. Pfau (2012a) provides an overview of this literature, dividing studies between those based on examining rolling periods from the U.S. historical data, Monte Carlo simulations with parameters chosen based on the historical data, and Monte Carlo simulations with parameters defined differently from the US historical record. Kitces (2012) also provides a thorough overview of the research on these questions extending back to Bengen (1994). He addresses how the initial studies have been modified to consider factors such as taxes, expenses, time horizons, deeper asset class diversification, variable spending, risk tolerance, market valuations, partial annuitization, and desires to leave a legacy.

To extend the literature review here, we specifically focus on studies of sustainable withdrawal rates in retirement in which asset allocations are not fixed. The earliest study about the impact of asset allocation glidepaths on retirement sustainability is Bengen (1996), who focused on the comparison between fixed asset allocations and declining equity glidepaths. In particular, he compared maintaining a fixed 63% stock allocation over retirement to strategies with various annual reductions to the stock allocation over a 30 year period. He found that the SAFEMAX (the highest sustainable withdrawal rate in the worst-case scenario from history) became smaller and smaller as the pace of the stock phasedown increased (i.e., sustainable withdrawals were *lower* when equity exposure declined through retirement). However, Bengen also found that with rolling historical simulations, a phasedown in the stock allocation did help to protect the remaining portfolio value, and with modest declining glidepaths the SAFEMAX impact was modest, and thus concluded that a 1% annual phasedown in the stock allocation was an appropriate compromise between growing wealth, supporting the withdrawal rate, and reducing late retirement volatility.

Subsequently, Blanchett (2007) used Monte Carlo simulations to test fixed asset allocations against a wide variety of glidepaths that reduce the equity allocation during retirement. Evaluated using numerous outcome metrics, he concluded that fixed asset allocations provided superior results to those reducing the equity allocation later in retirement. As he did not consider rising equity glidepaths, we note that fixed asset allocations are as close as one could get to a rising equity glidepath within the universe of glidepaths considered in his article.

More generally, the literature indicates three potential reasons to vary the asset allocation over retirement. The first of these is a valuation-based approach in which asset allocation adjusts to stock market valuation levels. This is explored in studies such as Kitces (2009) and Pfau (2012b). A second approach is to consider asset liability matching, in which assets are linked to specific goals, and in which asset allocation may evolve in a dynamic manner with safer assets used to meet essential needs and more volatile assets used to meet discretionary expenses. Huxley and Burns (2004) exemplify this approach from a more probability-based outcome perspective, while Branning and Grubbs (2010) justify the idea from a safety first perspective with assets that are "safe, secure, and sustainable" to meet essential needs. With these approaches, the overall asset allocation of the portfolio may vary over time as assets are used for specific purposes. With this framework, one does not set an asset allocation in advance, but asset allocation is whatever results from the process of asset-liability management.

Relatedly, Fan, Murray, and Pittman (2013) develop an adaptive model which considers a client's spending needs and uses equity exposure as a lever to manage shortfall risk. They find that beginning retirement with a lower equity allocation reduces the sequence of returns risk, and that the equity allocation may become more aggressive later in retirement when the client enjoys at least satisfactory market performance.

Finally, we consider the line of research most closely linked to this article, which are general tests of glidepaths separated from individual specific spending goals, instead looking to find what is feasible and how to obtain the largest sustainable withdrawals from a portfolio. As such studies are not specifically linked to the essential and discretionary spending needs of the client, the studies can be interpreted more from the perspective of the question about what should be the default glidepath for target date funds in the post-retirement period, or the default strategy from which advisors and their clients can deviate based on individual needs and circumstances. The closest related article is Spitzer and Singh (2007), who determine that rebalancing the asset allocation for a retirement income portfolio is not important, and that a strategy of spending bonds first does not increase shortfall risk. Although not specifically articulated, these findings imply a beneficial impact for a rising equity glidepath. Finally, Kitces and Pfau (2013) examine glidepath effects in the context of understanding the different ways that partial annuitization impacts a retirement income portfolio, and find that some of the implied benefits of partial annuitization can actually be attributed to the rising equity glidepath the strategy creates when viewed from a household balance sheet perspective.

We would be remiss not to highlight the fact that a corresponding literature also exists for the accumulation phase as individuals save for their retirement. Those studies look at how different asset allocation glidepath strategies impact the amount of wealth accumulated at the targeted retirement date. One direction in that research was to focus on whether declining glidepaths increase the probability of reaching a certain retirement wealth goal compared to asset allocations that stay fixed over time. By focusing on the probability of meeting a particular goal, such studies tend not to place much importance on the distribution of outcomes or the likelihood of experiencing a particularly bad outcome. For instance, Schleef and Eisinger (2007) use a Monte Carlo simulation and find that four different stylized declining equity glidepaths provide an equal or lesser chance of reaching a retirement wealth target than does a constant 70/30 allocation to stocks and corporate bonds. Since they define shortfall risk as the probability of not accumulating as much as the predetermined wealth goals, they justify maintaining a higher equity allocation near the target date, in contrast with the approach of lifecycle funds. They note that “the data suggest that the presumed advantages of minimizing equity allocations over time is a dubious one” (page 242). More recently, Schleef and Eisinger (2011) update earlier findings which support high stock allocations near retirement in order to maximize the probability of reaching a particular wealth accumulation goal.

Likewise, Basu and Drew (2009) argue that reducing equity allocations as retirement approaches is counterproductive to the retirement saving goals of typical individual investors. They attribute this to the portfolio size effect, an idea stemming from Shiller (2005) indicating that most of the portfolio growth for an individual will occur late in their career when there is more absolute wealth that can take advantage of capital gains. Basu and Drew (2009) argue that this leads target date funds to switch to conservative assets at precisely the wrong time, missing the main chance for asset growth as the target date approaches. Instead, unless an investor has already saved a sufficient amount to finance a comfortable retirement (which does not represent the situation of a typical saver), Basu and Drew argue that a high equity allocation should be maintained in target date funds, a conclusion opposite to the conventional wisdom. They obtain these results by comparing stylized lifecycle strategies to contrarian strategies that become more aggressive, rather than less aggressive, as the target date approaches.

Pfau (2010) countered these conclusions, demonstrated that when considering wealth accumulation in a utility maximizing framework that places more weight on avoiding extremely low wealth accumulations, risk averse investors may reasonably favor decreasing stock allocations near retirement. Pfau (2011) also demonstrated that risk averse investors may also prefer lower stock allocations even compared to a "reverse glide paths" scenario.

Methodology

This research investigates the sustainability of constant inflation-adjusted spending strategies from a portfolio of financial assets. Our hypothetical retirees are attempting to finance a particular spending goal, which is an inflation-adjusted amount equal to either 4% or 5% of initial retirement date assets, and to sustain that income stream for a set number of retirement years (the baseline results presented here are for retirements of 30 years, but we have also considered 20 and 40 year retirements and will briefly discuss those results as well).

The Maximum sustainable Withdrawal Rate (MWR) is the highest withdrawal rate that would have provided a sustained real income over a given retirement duration. At the beginning of the first year of retirement, an initial withdrawal is made equal to the specified withdrawal rate times accumulated wealth. Remaining assets then grow or shrink according to the asset returns for the year. At the end of the year, the remaining portfolio wealth is rebalanced to the targeted asset allocation. In subsequent years, the withdrawal dollar amount adjusts by the previous year's inflation rate and the order of portfolio transactions is repeated. Withdrawals are made at the start of each year and the amounts are not affected by asset returns, so the current withdrawal rate (the withdrawal amount divided by remaining wealth) differs from the initial withdrawal rate in subsequent years. If the withdrawal pushes the account balance to zero, the withdrawal rate was too high and the portfolio failed. The MWR is the highest rate that succeeds. Taxes are not specifically incorporated and any taxes associated with the entire portfolio would still need to be paid (separately, diminishing the growth, or from the withdrawals themselves).

Within this context, we investigate four outcome measures. First, the failure rate, which is the probability of financial asset depletion over different time horizons (20, 30, or 40 years) for those using either 4% or 5% initial withdrawal rates with subsequent inflation adjustments to those amounts.

Second, we focus on the potential magnitude of failure (as the probability of depletion alone gives no information about how severe the failure may have been). We evaluate magnitude of failure by measuring the amount of financial assets remaining in the 5^{th} percentile of the distribution of outcomes when using a 4% or 5% withdrawal rate. If the failure rate for the strategy was greater than 5% (i.e., there was a more-than-5% probability of depletion), then remaining financial assets will be negative, indicating a shortfall below the client's lifetime spending goal. In this case, we calculate the shortfall as the sum of inflation-adjusted spending needs (in today's dollars) which could not be satisfied over the retirement period without any further discounting of these values. If the failure rate was less than 5%, then there will be a surplus of wealth at the 5^{th} percentile of the distribution, which we report in real terms in today's dollars. The shortfall or surplus shown is based on total retirement date wealth of 100. Given annual spending amounts of 4% or 5% (of real starting wealth), a shortfall of -12 with a 4% withdrawal rate means that the retiree ran out of financial assets with three years left in the retirement period; alternatively, a legacy of +16 would indicate there was 4 years' worth of spending still remaining (subject to the impact of subsequent market returns), even in the 5^{th} percentile outcome. This measurement provides an indication of the magnitude of failure, because a larger spending shortfall implies that financial assets were depleted sooner in the retirement period.

Third, we reflect on the upside potential of the strategy. This measure is the real amount (in today's dollars) of financial assets remaining at the end of the retirement period in the median outcome of the Monto Carlo simulations. In half of cases, clients could expect to have even greater wealth, but in half of cases the remaining wealth will be less.

Finally, we provide information about the maximum sustainable withdrawal rate supported at the 10th percentile of outcomes. This measure indicates that in 10% of cases the sustainable withdrawal rate was even less, but in 90% of cases sustainable retirement income would have been higher (and/or taking withdrawals at a lower rate would result in a greater final legacy).

These outcome measures are calculated from 10,000 Monte Carlo simulations for 121 lifetime asset allocations glidepaths. At retirement, the initial stock allocation ranges from between zero and 100% in 10 percentage point increments (11 possibilities). The asset allocation in the final year retirement also ranges between zero and 100% in 10 percentage point increments. In the intervening years of the retirement, the asset allocation of the glidepath adjusts annually in a straight line between the initial and final asset allocation.

For one example, consider a 30 year retirement. With an initial stock allocation of 30% and a final stock allocation of 60%, in each year of retirement the portfolio rebalances to a stock allocation that rises by 1% per year over the 30 years. After 10 years, the stock allocation is 40%, and 25 years into retirement the stock allocation is 55% (and by the 30th year, the allocation is 60%). This approach allows for fixed glidepaths, declining equity glidepaths, and rising equity glidepaths of varying degrees, depending on the starting and end points and the magnitude of the difference between them (and the number of years to execute the glidepath itself).

Table 1 shows the *real* return capital market expectations used to guide the 10,000 Monte Carlo simulations. For the baseline, we use the real return assumptions prepared by Harold Evensky for the popular financial planning software MoneyGuidePro as of July 2013. In order to understand more about the implications for different capital market assumptions, we also consider a second scenario more closely calibrated to the low interest rate environment affecting today's retirees (but still assuming an equity risk premium comparable to historical returns), and a third scenario with both stock and bond returns based on the more optimistic historical real return averages found in Ibbotson's *Stocks*, *Bonds*, *Bills, and Inflation* yearbook. Simulations are made in each case with a multivariate lognormal distribution defined by these parameters. In essence, the scenarios vary either assumptions for real bond returns, real stock returns, and/or the equity risk premium.

// Table 1 About Here //

Results

Across all time horizons and withdrawal rates, when examining the approach which provides the highest sustainable withdrawal rates given a prospective 10% failure rate, the results consistently show support for rising equity glidepath portfolios. Declining equity glidepaths do not necessarily help support retirement success, and even static allocations generally fare worse than more conservative starting allocations that rise in equity exposure throughout retirement. Generally, depending on the underlying assumptions, the optimal starting equity exposures are around 20% to 40% and they finish at around 40% to 80%. With the Evensky return assumptions, the optimal end point of the glidepath was generally less than with other assumptions, as the equity risk premium is less (which reduces the return-enhancing benefits of equities). Nonetheless, some degree of a rising glidepath is still supported with all three sets of capital market assumptions.

When modeled relative to the success of a 4% or 5% withdrawal rate in particular, the results varied depending on the details of the return assumptions and the target spending level. For instance, Table 2 shows the success rates at a 4% withdrawal rate using the Evensky assumptions for various glidepaths, demonstrating that rising equity glidepaths generally fared best by a small margin. The highest success rate on the chart, signified by the standalone box around the result, shows that an initial allocation of only 30% in equities at retirement, rising to 80% by the end of retirement, actually provided the highest success. More generally, any allocations that begin at 20% to 40% in equities and finish at 60% to 80% provided the highest success rates, which is notable given that they have less equity exposure during the years when the portfolio size effect is greatest. In addition, these outcomes are typically superior to static asset allocations that simply maintain the same average equity exposure throughout retirement.

When examined from the perspective of the potential shortfall at the 5th percentile (given that 4% withdrawal rates at the reduced Evensky returns for 30-year time horizons do show some risk of failure on a Monte Carlo basis), the results reveal that rising glidepaths are even more effective, especially when they start off conservatively. The most favorable (i.e., least adverse) shortfall actually occurs with a glidepath that starts at only 10% in equities and rises to "only" 50% in equities (when viewing the maximal withdrawal rate at the 10th percentile, a similar result occurs, with the optimal portfolio starting at 20% in equities and ending at 40%). Notably, from this shortfall perspective, in general portfolios that start off in the 10% to 30% equity range and utilize rising glidepaths fare *far* better than static portfolios with 50% or 60% in equities (as well as portfolios that start with those asset allocations and decline).

From the perspective of traditional retirement planning and projections, these results may seem surprising, and the third panel reveals why: when viewed from the perspective of the median amount of wealth at the end (i.e., analogous to what would result from running a straight-line projection), results just improve as the equity exposures increase, given that "on average" higher equity exposures result in greater average returns. In other words, when viewing "average" (or actually, median) results, greater equity exposures are more appealing, and it's only when examined from the perspective of risk and magnitude of shortfalls that the optimal portfolios not only contain far less equity exposure on average, but perform best when the equity exposure starts very low and rises throughout retirement, even if the final equity allocations at the end of retirement are "surprisingly" high.

When tested at higher withdrawal rates – where the risk of failure rises even more, especially using Evensky returns – the results reveal that retirees fare best with the greatest equity risk at the beginning of retirement, as the top performing scenarios all begin with 80%-100% in equities. This isn't entirely surprising; if the withdrawal rate places enough pressure on the portfolio's potential growth rate, at some point taking significant risks in equities – notwithstanding the danger that entails – is still the best path to maximize the likelihood of success. Notably, though, from the perspective of viewing the magnitude of potential shortfalls, the optimal portfolio remains a rising equity glidepath (starting at 10% in equities and finishing at 60%), which is remarkably similar to the 4% withdrawal rates at the same returns.

Investigating a lower return environment in Tables 4 and 5, which assumes that fixed income returns sustain at today's ultra-low levels but that the historical equity risk premium remains intact, the results create a more noticeable distinction. When simply trying to maximize the probability of success, retirees are 'compelled' to take significant equity risk, and the best portfolios all start and finish at significant equity exposures. However, for those trying to manage the potential retirement shortfall (especially given the material risk exposure), again more conservative rising equity glidepaths fare better (minimizing the magnitude of the shortfall, even while they increase its likelihood).

Tables 6 and 7 show the results of the glidepaths using long-term historical returns. In this scenario, with both higher overall returns and a greater equity risk premium, rising equity glidepaths perform even better, and the results are more consistent in showing an optimal retirement glidepath that begins at 30% in equities and rises to 70% in equities by the end (in terms of both probability of failure and magnitude of failure). In the higher return environment, these portfolios fare noticeably better than 60/40 static portfolios, and materially better than just keeping the portfolio invested conservatively throughout. At a higher 5% withdrawal rate, the results are generally still the same, though the greater pressure on withdrawals generally increases the benefit of starting (and finishing) with slightly more in equities overall to have a reasonable chance of generating the requisite returns.

We also considered shorter time horizons of 20 years and the results hold as well. Rising equity glidepaths that start around 20%-40% in equities and finish at 50%-70% in equities are generally optimal, at least as long as there is still a reasonable equity risk premium. Using the Evensky assumptions with a compressed equity risk premium, the optimal results start with almost no equities and only increase that exposure to about 30% by the end; given the shorter time horizon, there simply isn't much time for equities to provide a benefit in light of their volatility.

With longer time horizons (40 years), the results are again consistent. In situations where the combination of returns and withdrawal rates stresses the portfolio, the optimal results to minimize the risk of failure have fairly significant equity exposure, but the approach to minimize the magnitude of failure still involves a rising equity glidepath. When the equity risk premium is reduced (e.g., the Evensky assumptions), the starting equity exposure of the glidepath is lower, but the rising equity glidepath is still superior to manage potential shortfalls.

Implications for Financial Planners

The implications of this research for financial planners are significant; it implies that the traditional approach of maintaining constant asset allocations in retirement to which the client is routinely rebalanced are actually far less than optimal. While such an approach is actually superior to *decreasing* equity exposure through retirement – as shown in prior research, which our results support – the results of this study reveal that in fact the best solution may be to steadily *increase* equity exposure throughout retirement.

This result may appear counterintuitive from the traditional perspective, which is that equity exposure should decrease throughout retirement as the retiree's time horizon (and life expectancy) shrinks and mortality looms. Yet the conclusion is actually entirely logical when viewed from the perspective of what scenarios cause a client's retirement to "fail" in the first place.

The success of a retirement scenario is heavily influenced by the sequence of returns. As Kitces (2008) showed, in the case of a 30-year time horizon, the outcome of a withdrawal scenario is dictated almost entirely by the real returns of the portfolio for the first 15 years. If the returns are good (e.g., an early bull market), the retiree is so far ahead relative to the original goal, that a subsequent bear market in the second half of retirement has little impact; yes, final wealth may be highly volatile in the end, but the initial spending goal will not be threatened. By contrast, if the returns are bad in the first half of retirement, the portfolio is so stressed that the good returns that follow (as stock valuations eventually become very cheap) are absolutely crucial to carry the portfolio through to the end.

In this context, the problem with declining equity glidepaths suddenly becomes clear. In scenarios that threaten retirement sustainability – e.g., an extended period of poor returns in the first half of retirement – a declining equity exposure over time will lead the retiree to have the least in stocks when the good returns finally show up in the second half of retirement. By contrast, this is also why rising equity glidepaths perform better; in a situation where the first half of retirement is bad (e.g., the 1929 or late 1960s retiree), rising equity exposure leads the retiree to systematically dollar cost average into equities through flat or declining markets, maximizing exposure by the time the good returns finally show up (e.g., after World War II or starting in the 1980s) and helping to sustain greater retirement income over the entire time period. In other words, in the scenarios where equity returns are bad early on, rising equity glidepaths are crucial, and in scenarios where equity returns are good early on, the retiree is so far ahead it doesn't matter (relative to achieving the original goal). In essence, then, rising equity glidepaths create a "Heads you win, tails you don't lose" outcome in securing a starting goal. (Obviously, retirees who are far ahead may choose to decrease their equity exposure later simply because they have a significant amount of newfound wealth, but the point remains that they don't *need* to reduce their equity exposure to secure their goals if they're that far ahead in the first place.)

Accordingly, as the results support, for those looking to maximize their level of sustainable retirement income, and/or to reduce the potential magnitude of any shortfalls in adverse scenarios, portfolios that start off in the vicinity of 20% to 40% in equities and rise to the level of 60% to 80% in equities generally perform better than static rebalanced portfolios or declining equity glidepaths. Though as the results also reveal, in particular scenarios where the equity risk premium is depressed, the optimal glidepath includes less equity, and in scenarios where the goal is to withdraw at a level that stresses the portfolio and its expected growth rate, higher overall levels of equity are necessary; with such high-risk goals, having a relatively high-risk portfolio, with the danger that entails, is still the optimal solution (and for clients who cannot tolerate that level of risk, the ideal solution is to choose not a less risky portfolio, but a less risky and aggressive goal). Nonetheless, for everyone else looking to maximize a sustainable income level, or determine the amount of assets to support a (reasonable) target income level, rising equity glidepaths appear to both maximize the likelihood of success and sustainable income *and* reduce the magnitude of shortfalls when they occur.

Notably, the clear caveat and concern of this approach is that it may also create concerns for seniors in their later years, who may not be comfortable from a risk tolerance perspective handling the greater equity exposures implied by this approach (even if the results would technically be optimal from the mathematical and markets perspective). On the other hand, it's notable that in many scenarios, the optimal rising equity glidepaths still finish with little more in equities than the 60/40 portfolios that are commonly used by many planners anyway. In addition, planners may be able to find ways to frame rising equity glidepath strategies in a manner that is more comfortable for clients; for instance, a "bucket strategy" that draws heavily from the fixed income allocation in the early years and allows equities to grow is effectively a rising glidepath strategy, but may be more tolerable when explained as a bucket strategy. Similarly, Kitces and Pfau (2013) previously showed that in fact partial annuitization strategies also essentially represent a form of a bucketing-based rising equity glidepath approach.

Ultimately, most financial planners will still craft customized, individualized recommendations for their clients, not necessarily use glidepaths (rising or otherwise); furthermore, most planners will still be monitoring a client's progress on an ongoing basis, making adjustments as necessary rather than based upon a static formula. Nonetheless, the results of this study are significant, as it implies that the 'default' glidepath *should* be to start with a much lower equity exposure than is traditionally used, and increase it over time, and that further actions from the planner and client should be intentional efforts (if and only if appropriate) to deviate from this default. Similarly, in the case of the exploding industry of target date funds, the idea that funds used through retirement should have a rising equity glidepath would indicate a significant need to change from the status quo.

Implications for Future Research

Given the significantly disruptive implications of this research compared to how retirees are typically guided to invest in retirement, we see several different avenues for additional research.

One option is to test a wider range of rising glidepaths. The methodology of this study assumes a straight-line linear increase in the glidepath from the starting to ending target equity exposures over whatever time horizon applies. Further research might explore whether it would be better to accelerate the glidepath earlier in retirement, or alternatively to slow it in the early years and accelerate later.

Another extension of this research would be to incorporate measures of valuation more directly. As Kitces (2009) showed, making adjustments based on market valuation can enhance retirement income success even from a static baseline, and as noted earlier the general reason why rising equity glidepaths appear to perform well is that they end up increasing equity exposure in scenarios where stocks provide mediocre returns and "get cheap" in the first half of retirement. Given that in other scenarios markets perform well in the early years, a more optimal glidepath approach might make glidepath adjustments based not on time-based triggers but valuation-based triggers, allowing equity exposure to increase as stocks get cheaper but also allowing exposure to remain the same or even decline if stock prices are rising. In fact, given that the favorable scenarios for rising equity glidepaths revolve almost entirely around scenarios where poor market returns early on make stocks "cheap" for the second half of retirement, it's possible that ultimately the rising equity glidepath strategy is simply a rules-based approach to ensure that retirees purchase a sufficient amount of equities when valuations are most favorable.

A third extension of this study for further research is to apply its approach more fully over the entire lifecycle, integrating the accumulation and retirement phases together well, especially given the prevalence of target date funds and their declining equity glidepaths for those still saving for retirement. Should the direction of the glidepath change right at the moment an individual makes the retirement transition, such as a U-shaped glidepath where equities decline leading up to retirement and then rise once retirement begins? And can market valuation impact the accumulator glidepaths as well?

Ultimately, a great deal of further research is necessary to explore these effects further. Nonetheless, the bottom line remains that in a world where retirees by default have had a tendency to decrease equity exposure over time, our research suggests that this fundamental assumption may need to be revisited.

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Table 1

Scenario A: Modelled on Evensky Assumptions for MoneyGuidePro

	Real Returns			Correlation Coefficients		
	Arithmetic Means	Geometric Means	Standard Deviations	Stocks	Bonds	Inflation
Stocks	5.50%	3.37%	20.7%	1	0.3	-0.2
Bonds	1.75%	1.54%	6.5%	0.3	1	-0.6
Inflation	3.00%	2.91%	4.2%	-0.2	-0.6	1
Equity Premium	3.75%					

Scenario B: Lower Future Returns

	Real Returns			Correlation Coefficients		
	Arithmetic Means	Geometric Means	Standard Deviations	Stocks	Bonds	Inflation
Stocks	5.10%	3.10%	20.0%	1	0.1	-0.2
Bonds	0.30%	0.06%	7.0%	0.1	1	-0.6
Inflation	2.10%	2.01%	4.2%	-0.2	-0.6	1
Equity Premium	4.80%					

Scenario C: Historical Data
Summary Statistics for U.S. Real Returns Data, 1926 - 2011

	Real Returns			Correlation Coefficients		
	Arithmetic Means	Geometric Means	Standard Deviations	Stocks	Bonds	Inflation
Stocks	8.59%	6.46%	20.7%	1	0.1	-0.2
Bonds	2.56%	2.35%	6.5%	0.1	1	-0.6
Inflation	3.07%	2.98%	4.2%	-0.2	-0.6	1
Equity Premium	6.03%					

Source: Own calculations from Stocks, Bonds, Bills, and Inflation data provided by Morningstar and Ibbotson Associates. The U.S. S&P 500 index represents the stock market, and intermediate-term U.S. government bonds represent the bond market.

Table 2

30-Year Retirements, Harold Evensky's Capital Market Expectations

Success Rate for a 4% Withdrawal Rate

Starting Allocation \ Ending Allocation	0	10	20	30	40	50	60	70	80	90	100
0	55	59	62	64	66	68	70	70	71	71	71
10	62	65	67	69	71	72	72	73	73	73	73
20	67	69	71	72	73	74	74	74	74	74	74
30	70	72	73	73	74	74	74	74	74	74	74
40	72	73	73	74	74	74	74	74	74	74	73
50	72	73	73	73	74	74	73	73	73	73	73
60	72	72	73	73	73	73	73	72	72	72	71
70	71	72	72	72	72	72	72	71	71	71	70
80	71	71	71	71	71	71	71	70	70	70	69
90	70	70	70	70	70	70	69	69	69	68	68
100	69	69	69	69	69	68	68	68	67	67	66

Legacy/Shortfall at the 5th Percentile of the Distribution for a 4% Withdrawal Rate

Starting Allocation \ Ending Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-32	-31	-30	-29	-29	-29	-28	-28	-28	-28	-29
10	-29	-29	-28	-28	-28	-28	-28	-28	-28	-29	-30
20	-29	-28	-28	-28	-28	-29	-29	-29	-30	-30	-31
30	-29	-29	-30	-30	-30	-31	-31	-32	-32	-33	-34
40	-32	-32	-32	-32	-33	-33	-34	-34	-35	-36	-37
50	-34	-35	-35	-36	-36	-37	-37	-38	-39	-39	-40
60	-38	-38	-39	-39	-40	-40	-41	-42	-43	-43	-44
70	-42	-42	-42	-43	-44	-44	-45	-45	-46	-47	-47
80	-45	-46	-46	-47	-48	-48	-49	-49	-50	-50	-51
90	-49	-50	-50	-51	-51	-52	-52	-53	-53	-54	-55
100	-53	-54	-54	-55	-55	-56	-56	-57	-57	-58	-58

Legacy/Shortfall at the Median of the Distribution for a 4% Withdrawal Rate

Starting Allocation \ Ending Allocation	0	10	20	30	40	50	60	70	80	90	100
0	4	6	9	12	14	17	19	21	23	25	27
10	10	13	15	18	20	23	25	28	29	31	33
20	15	18	21	23	26	28	31	33	34	36	37
30	20	23	26	28	31	34	36	38	39	41	41
40	24	27	30	33	36	38	40	42	44	45	46
50	29	32	35	37	40	42	44	46	48	48	49
60	33	36	39	42	44	46	48	50	51	52	52
70	37	39	43	45	48	49	51	53	54	54	54
80	40	43	46	48	50	52	53	54	56	56	56
90	43	46	49	51	52	54	55	55	56	56	56
100	45	48	50	52	54	55	56	56	56	56	56

Maximum Sustainable Withdrawal Rate with a 10% Failure Rate

Starting Allocation \ Ending Allocation	0	10	20	30	40	50	60	70	80	90	100
0	3.2	3.3	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.3
10	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3
20	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3	3.3
30	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.2
40	3.3	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.2	3.2	3.2
50	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.1	3.1	3.1
60	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.0	3.0	3.0
70	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.8
80	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.7	2.7
90	2.9	2.9	2.8	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.6
100	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.5	2.5	2.4

Table 3
30-Year Retirements, Harold Evensky's Capital Market Expectations

Success Rate for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	14	16	17	20	22	24	26	28	30	32	33
10	19	21	23	25	28	30	32	33	35	36	38
20	24	27	29	31	33	35	37	38	39	41	41
30	31	33	35	37	38	40	41	42	43	44	45
40	36	38	40	41	42	43	45	45	46	46	47
50	41	42	43	45	46	46	47	47	48	48	48
60	44	45	46	47	48	48	49	49	49	49	49
70	46	47	48	49	49	50	50	50	50	50	50
80	48	49	50	50	51	51	51	51	51	51	51
90	49	50	51	51	51	51	51	51	51	51	51
100	50	51	51	51	52	52	51	51	51	51	51

Legacy/Shortfall at the 5th Percentile of the Distribution for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-61	-61	-60	-60	-59	-59	-59	-59	-59	-59	-59
10	-59	-59	-59	-59	-59	-59	-59	-59	-59	-59	-60
20	-59	-59	-59	-59	-59	-60	-60	-60	-61	-61	-61
30	-60	-60	-60	-60	-61	-61	-62	-62	-62	-63	-64
40	-62	-62	-63	-63	-63	-64	-64	-65	-65	-66	-66
50	-65	-66	-66	-66	-67	-67	-67	-68	-68	-69	-69
60	-68	-69	-69	-70	-70	-70	-71	-72	-72	-72	-73
70	-72	-72	-73	-73	-74	-74	-75	-75	-75	-76	-76
80	-76	-76	-77	-77	-77	-78	-78	-78	-79	-79	-80
90	-79	-80	-80	-81	-81	-81	-82	-82	-83	-83	-83
100	-83	-83	-84	-84	-85	-85	-85	-86	-86	-86	-87

Legacy/Shortfall at the Median of the Distribution for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-32	-30	-29	-28	-27	-26	-24	-23	-22	-22	-21
10	-28	-26	-25	-24	-22	-21	-20	-19	-18	-17	-16
20	-24	-22	-21	-20	-18	-17	-16	-15	-14	-13	-12
30	-20	-18	-17	-15	-14	-13	-12	-11	-10	-10	-9
40	-16	-15	-13	-12	-11	-10	-9	-8	-7	-6	-6
50	-12	-11	-10	-8	-7	-6	-6	-5	-5	-4	-4
60	-9	-7	-6	-5	-4	-3	-2	-2	-2	-2	-1
70	-6	-5	-3	-2	-2	-1	0	0	1	1	1
80	-3	-2	-1	0	1	2	2	2	2	2	2
90	-1	0	1	3	3	3	3	3	3	3	2
100	1	2	3	4	4	4	4	4	3	2	2

Table 4

30-Year Retirements, Lower Future Returns

Success Rate for a 4% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	19	22	25	28	31	35	38	41	43	45	47
10	25	29	32	36	40	43	46	48	50	52	53
20	33	37	41	44	47	50	52	54	56	57	58
30	42	45	48	51	54	56	57	59	60	61	61
40	48	51	53	56	58	59	61	62	62	63	63
50	53	56	58	59	61	62	63	63	64	64	64
60	57	59	61	62	63	63	64	64	65	65	65
70	60	61	62	63	64	64	64	65	65	65	65
80	61	62	63	64	64	65	65	65	65	65	65
90	62	63	64	64	64	65	65	65	65	65	65
100	63	63	64	64	64	65	65	65	65	65	64

Legacy/Shortfall at the 5th Percentile of the Distribution for a 4% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-45	-44	-43	-43	-42	-42	-41	-41	-40	-40	-40
10	-42	-41	-41	-40	-40	-39	-39	-39	-39	-39	-39
20	-40	-39	-39	-38	-38	-38	-38	-38	-38	-38	-39
30	-39	-39	-38	-38	-38	-38	-38	-39	-39	-39	-40
40	-39	-39	-39	-39	-39	-39	-40	-40	-40	-40	-41
50	-40	-40	-41	-41	-41	-41	-41	-42	-42	-42	-43
60	-42	-42	-43	-43	-43	-44	-44	-44	-45	-45	-46
70	-45	-45	-45	-45	-46	-46	-47	-47	-48	-48	-49
80	-47	-48	-48	-48	-49	-49	-50	-50	-51	-51	-52
90	-50	-51	-51	-52	-52	-53	-53	-54	-54	-54	-55
100	-54	-54	-54	-55	-55	-56	-56	-57	-57	-58	-58

Legacy/Shortfall at the Median of the Distribution for a 4% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-20	-18	-16	-15	-13	-11	-9	-7	-6	-4	-2
10	-15	-13	-12	-10	-8	-6	-3	-2	0	2	3
20	-11	-8	-6	-4	-2	0	2	4	6	8	9
30	-6	-4	-1	1	3	5	7	10	11	13	15
40	-1	1	3	6	8	10	12	14	16	18	20
50	3	5	8	11	13	15	18	20	22	23	25
60	7	10	13	16	18	20	23	25	27	28	29
70	12	15	17	20	23	25	27	29	31	32	34
80	16	19	21	24	27	29	31	33	35	36	37
90	19	22	25	28	30	32	34	36	38	39	40
100	23	25	28	31	33	35	37	39	40	41	42

Maximum Sustainable Withdrawal Rate with a 10% Failure Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	2.5	2.6	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9	2.9
10	2.7	2.7	2.8	2.8	2.9	2.9	2.9	2.9	3.0	3.0	3.0
20	2.8	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0
30	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
40	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9
50	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9
60	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8
70	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7
80	2.7	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.6
90	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5
100	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.4	2.4

Table 5

30-Year Retirements, Lower Future Returns

Success Rate for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	2	3	3	4	5	6	7	9	10	12	14
10	3	4	5	6	8	10	11	13	15	17	19
20	6	7	9	11	13	15	17	19	21	23	25
30	10	12	14	17	19	21	23	25	27	29	30
40	16	19	21	23	25	27	29	31	32	34	35
50	23	25	27	28	30	32	34	35	37	38	39
60	28	30	32	33	35	37	38	39	40	41	42
70	33	35	36	38	39	40	41	42	43	43	44
80	37	39	40	41	42	43	43	44	44	45	46
90	40	41	42	43	44	45	45	46	46	46	47
100	43	44	44	45	46	46	47	47	47	47	48

Legacy/Shortfall at the 5th Percentile of the Distribution for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-73	-72	-72	-71	-71	-70	-70	-70	-69	-69	-69
10	-70	-70	-69	-69	-68	-68	-68	-68	-68	-68	-68
20	-68	-68	-68	-67	-67	-67	-67	-67	-68	-68	-68
30	-68	-68	-68	-68	-68	-68	-68	-68	-68	-68	-68
40	-68	-68	-68	-68	-68	-69	-69	-69	-69	-70	-70
50	-69	-70	-70	-70	-70	-70	-71	-71	-71	-72	-72
60	-71	-72	-72	-72	-72	-73	-73	-73	-74	-74	-74
70	-74	-74	-74	-75	-75	-75	-75	-76	-76	-77	-77
80	-77	-77	-77	-77	-78	-78	-78	-79	-79	-80	-80
90	-80	-80	-80	-81	-81	-81	-82	-82	-82	-82	-83
100	-83	-83	-83	-84	-84	-84	-85	-85	-85	-86	-86

Legacy/Shortfall at the Median of the Distribution for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-50	-49	-48	-47	-46	-45	-44	-43	-42	-41	-40
10	-46	-45	-44	-43	-42	-41	-39	-38	-37	-36	-35
20	-42	-41	-40	-39	-37	-36	-35	-34	-33	-32	-31
30	-38	-37	-36	-34	-33	-32	-31	-30	-29	-28	-28
40	-35	-33	-32	-31	-30	-29	-28	-27	-26	-24	-23
50	-31	-30	-28	-27	-26	-25	-24	-23	-22	-21	-20
60	-28	-26	-25	-24	-23	-21	-20	-19	-18	-17	-16
70	-24	-23	-21	-20	-19	-18	-17	-16	-15	-14	-13
80	-21	-19	-18	-17	-16	-15	-14	-13	-12	-11	-11
90	-18	-16	-15	-14	-13	-12	-11	-10	-9	-9	-9
100	-15	-14	-13	-12	-11	-10	-9	-8	-7	-7	-7

Table 6

30-Year Retirements, Historical Average Capital Market Expectations

Success Rate for a 4% Withdrawal Rate

Ending Allocation

Starting Allocation	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	75	79	82	85	88	89	91	92	92	93	93
10	84	87	89	91	92	93	94	94	94	94	94
20	89	91	92	93	94	94	95	95	95	95	95
30	92	93	94	94	95	95	95	95	95	95	94
40	93	93	94	94	95	95	95	95	95	94	94
50	93	93	94	94	94	94	94	94	94	94	93
60	92	93	93	93	93	93	93	93	93	93	92
70	92	92	92	92	92	92	92	92	92	92	92
80	91	91	91	91	91	91	91	91	91	91	91
90	90	90	90	90	90	90	90	90	90	90	90
100	89	89	89	89	89	89	89	89	89	89	88

Legacy/Shortfall at the 5th Percentile of the Distribution for a 4% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-24	-21	-19	-17	-14	-13	-11	-9	-8	-7	-6
10	-17	-14	-12	-10	-8	-6	-4	-3	-3	-3	-3
20	-11	-9	-6	-5	-3	-2	-1	-1	-1	-1	-1
30	-7	-5	-4	-3	-1	-1	0	0	0	-1	-2
40	-7	-5	-4	-3	-2	-1	-1	-2	-2	-3	-4
50	-7	-6	-5	-4	-5	-5	-5	-6	-7	-8	-8
60	-10	-10	-9	-9	-9	-9	-9	-10	-11	-13	-13
70	-14	-14	-14	-14	-14	-15	-15	-16	-17	-17	-19
80	-18	-18	-19	-19	-20	-20	-21	-22	-22	-24	-24
90	-23	-24	-24	-25	-25	-26	-27	-27	-29	-29	-30
100	-28	-29	-29	-30	-31	-31	-32	-33	-34	-35	-36

Legacy/Shortfall at the Median of the Distribution for a 4% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	23	30	37	44	52	60	68	76	84	93	102
10	35	43	51	59	68	77	86	95	105	115	124
20	48	56	65	74	84	94	104	114	124	133	144
30	61	71	80	91	101	112	123	133	144	155	166
40	75	85	96	107	119	130	141	153	164	174	185
50	89	100	112	124	136	147	160	171	183	195	206
60	103	116	128	140	153	166	179	191	203	215	226
70	118	131	144	157	170	185	197	209	221	233	246
80	133	146	160	173	187	200	214	227	239	250	264
90	148	162	175	190	203	217	231	244	256	268	280
100	162	175	191	206	219	232	247	259	271	284	296

Maximum Sustainable Withdrawal Rate with a 10% Failure Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	3.5	3.6	3.7	3.8	3.9	4.0	4.0	4.1	4.1	4.1	4.2
10	3.8	3.9	4.0	4.0	4.1	4.2	4.2	4.2	4.2	4.3	4.3
20	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.3	4.3	4.4	4.4
30	4.1	4.2	4.2	4.3	4.3	4.3	4.3	4.4	4.4	4.4	4.4
40	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.4
50	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
60	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.2
70	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
80	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
90	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
100	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.8

Table 7

30-Year Retirements, Historical Average Capital Market Expectations

Success Rate for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	29	34	38	43	47	51	54	57	60	63	65
10	40	45	49	54	58	61	64	66	68	70	72
20	51	56	60	63	66	69	70	72	73	74	75
30	60	64	67	70	72	73	74	76	76	77	78
40	67	69	72	73	75	76	77	78	78	79	79
50	71	73	74	76	77	78	78	79	79	79	79
60	73	75	76	77	78	78	79	79	79	79	79
70	75	76	77	77	78	78	79	79	79	79	79
80	75	76	77	77	78	78	78	78	79	79	79
90	75	76	77	77	78	78	78	78	78	78	78
100	76	76	77	77	77	77	77	78	77	77	77

Legacy/Shortfall at the 5th Percentile of the Distribution for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-56	-55	-54	-52	-51	-50	-49	-48	-47	-46	-45
10	-50	-49	-48	-46	-45	-45	-44	-43	-43	-42	-42
20	-46	-45	-44	-43	-42	-42	-42	-41	-41	-41	-41
30	-44	-44	-43	-42	-42	-42	-42	-42	-42	-42	-42
40	-44	-43	-43	-43	-43	-43	-43	-43	-44	-44	-44
50	-46	-45	-45	-45	-45	-45	-46	-46	-47	-47	-47
60	-48	-48	-48	-49	-49	-49	-50	-50	-51	-51	-52
70	-51	-52	-52	-52	-53	-53	-54	-54	-54	-55	-56
80	-56	-56	-56	-57	-57	-57	-58	-59	-59	-60	-60
90	-60	-60	-61	-61	-61	-62	-62	-63	-63	-64	-64
100	-64	-65	-65	-65	-66	-66	-67	-67	-68	-68	-69

Legacy/Shortfall at the Median of the Distribution for a 5% Withdrawal Rate

Ending Allocation

Starting Allocation	0	10	20	30	40	50	60	70	80	90	100
0	-19	-16	-12	-8	-3	1	6	11	16	22	27
10	-9	-5	-1	5	10	16	21	27	33	39	45
20	1	6	12	18	24	30	36	43	50	58	64
30	12	18	25	32	38	46	53	60	68	75	82
40	24	31	38	46	54	61	69	77	85	93	101
50	36	44	52	61	69	77	85	94	102	109	117
60	49	58	66	75	84	93	102	111	118	126	133
70	62	70	80	89	99	108	117	126	135	143	150
80	75	84	94	103	113	123	132	141	150	158	165
90	88	98	107	117	127	137	145	154	164	172	180
100	100	110	121	131	140	151	160	170	178	186	194