# Introducing the Longevity Portfolio

*by David M. Blanchett, Ph.D., CFA, CFP®*

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## Executive Summary

- Outliving savings (i.e., longevity risk) is an important consideration when developing a financial plan for a retiree. Purchasing an annuity is widely regarded as the best approach to managing longevity risk; however, annuities remain relatively unpopular.
- Although a few mortality-linked investments exist, they are not widely utilized and will likely not be available, or attractive, for household portfolios for the foreseeable future.
- This paper introduces the concept of a "longevity portfolio," which is an investment strategy designed specifically to manage the increased potential costs associated with unexpected improvements in mortality using traditional securities, such as publicly traded stocks.
- The ability of a longevity portfolio to hedge unexpected changes in mortality rates is unknown. However, certain sectors, industries, and companies would likely benefit more from unexpected mortality improvements than others; and are, therefore, attractive additions to a retirement portfolio due to their hedging potential.
- Longevity portfolios can increase portfolio efficiency, perhaps considerably, even if they cost more than non-liability focused investment strategies (e.g., a traditional market capitalization weighted index) depending on the expectations, preferences, and situation of the respective household (consistent with the potential value of other liability-driven investing approaches).

**Annuities with benefit** payments linked to inflation (i.e., real annuities) have long been regarded as the optimal financial product for retirees because they provide income that is guaranteed for life and are linked to expected future changes in retiree spending, such as inflation. However, real annuities—as well as virtually all other types of annuities—remain relatively unpopular among retirees today, both in the U.S. and globally, an effect commonly referred to as the "annuity puzzle." Funding retirement with a traditional portfolio creates an imperfect hedge, since it subjects the retiree to the possibility of outliving savings, commonly referred to as longevity risk.

Retirement is the most expensive goal most households will ever have to fund, yet the underlying risks of the retirement liability are often ignored when constructing portfolios for households. While some approaches *implicitly* consider the risk of retirement (e.g., the portfolio that maximizes the probability of accomplishing the retirement goal is selected for a client), the unique risks of the retirement goal need to be more explicitly considered during the portfolio construction process.

Investment approaches that explicitly consider the risk structure of a goal (i.e., the liability) are generally referred to as liability-driven investing (LDI). While LDI has become increasingly common among pension plans, it is not widely used when creating household retirement portfolios. One reason for this is that pension liabilities have relatively known payments, while individual expenses can vary significantly. Optimal LDI portfolios can vary considerably from traditional asset-only models (e.g., mean variance optimization), and therefore, while they may appear inefficient using traditional risk metrics (e.g., return and standard deviation), they are actually "better" portfolios because they more explicitly address the fundamental purpose of the portfolio—to fund a goal, such as retirement.

This paper introduces the concept of a "longevity portfolio," which is

an investment strategy designed specifically to offset the potential increased costs associated with an *unexpected* improvement in mortality (i.e., increases in life expectancies). In theory, since expected mortality improvements are already known, they are incorporated into retirement projections and priced into market securities. While an investment directly linked to mortality rates would be the ideal asset to own in a longevity portfolio, mortality-linked investments are not widely used and will likely not be available—or attractive—for household portfolios for the foreseeable future.

Given this limitation, the longevity portfolio introduced in this paper focuses on widely available securities, such as publicly traded stocks with a fundamental exposure to changes in mortality, although in reality there is a wide range of investments that could be used.

Although the relation between a portfolio of stocks, for example, and unexpected changes in mortality rates is unknown, certain sectors (for example, healthcare), industries (nursing homes), and companies (those favored by elderly Americans) should benefit more from such an event than others, and are therefore attractive additions to a retirement portfolio due to their hedging potential.

The value of the longevity of a portfolio is going to vary based on the expectations, preferences, and situation of the respective household. However, a longevity portfolio has the potential to improve portfolio efficiency—potentially considerably—even if it costs more than non-liability focused options (e.g., a market capitalization weighted index), consistent with the potential value of other liability-driven investing approaches.

There is very little, if any, research on the topic of how to build a portfolio explicitly designed to hedge unexpected changes in mortality for households. The goal of this research is to introduce the topic and encourage future work in the space.

## Managing Longevity Risk Without Annuities

The potential benefit of annuities for retirees has been explored at some length, for decades. Early research by Yaari (1965), followed by many others, has demonstrated how allocating savings to annuities is a more efficient approach than self-funding longevity risk (self-annuitization). Annuities remain relatively unpopular, though, an effect commonly referred to as the "annuity puzzle."[1]

The lack of annuity demand has a number of possible explanations (for example, see Brown 2007), such as cost, liquidity, bequest motives, health status, financial literacy, etc. The reasons behind the lack of annuitization is beyond the scope of this paper. Rather, the goal of this paper is to explore how households can attempt to manage longevity risk using a more traditional portfolio framework without annuities.

Retirement is the largest financial liability faced by most households and is typically funded through some combination of financial (e.g., savings) and nonfinancial (e.g., pensions) assets. Early research on optimal portfolio funding strategies focused primarily on portfolio equity allocations. For example, Bengen (1994) noted in his seminal research that led to the widely cited "4 percent rule" that a portfolio should have an equity allocation between 50 percent and 75 percent in order to generate the highest probability of accomplishing the retirement goal, using historical U.S. market returns. Subsequent research using a variety of models has generally echoed these early findings and explored areas such as optimal asset classes, the role of expenses, the impact of varied returns, etc. While this type of modeling is an improvement over approaches that entirely ignore the retirement liability, these models only consider the risks of the retirement liability *implicitly*, since they do not seek to address how the duration of retirement could change based on changes in mortality rates.

It is unclear exactly when the traditional asset-only Markowitz (1952) approach was first extended to include liabilities, but approaches that explicitly consider the liability when determining the optimal portfolio (LDI), have been around since the late 1970s (Idzorek and Blanchett 2019). LDI comes in a variety of flavors, including the ultra-conservative approach of cash flow matching (matching the timing and size of cash flows from the assets with the required cash flows of the liability), followed by duration matching (matching the interest rate sensitivity of the asset portfolio to that of the liability), and liability-relative optimization.

LDI techniques generally require some modifications when used for household portfolios, versus pensions, to reflect the unique risks associated with funding the retirement liability. For example, retirees typically have a spending goal that is both inflexible ("hard" or "nondiscretionary") and flexible ("soft" or "discretionary"), a construct not typically relevant to pension plans where the need is entirely "hard" in nature. Given the differences in the situations and preferences among retiree households, the truly optimal retirement portfolio would vary at the individual household level, a point covered at length by Cochrane (2007) when discussing the impact of nonfinancial assets on optimal portfolios.

One risk that has been largely ignored, even among common LDI techniques focused on retirement, is the impact of an *unexpected* change in mortality rates (e.g., an unexpected increase in life expectancies). Changes in the expected length of retirement

**Figure 1: Cost Implications of a Sudden Change in Retirement Duration**

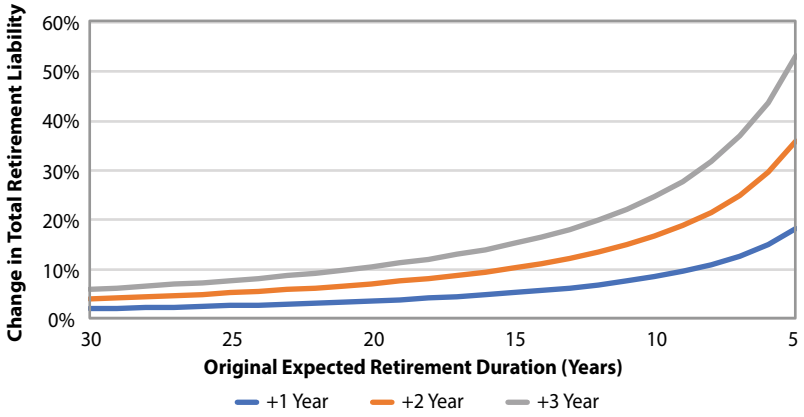
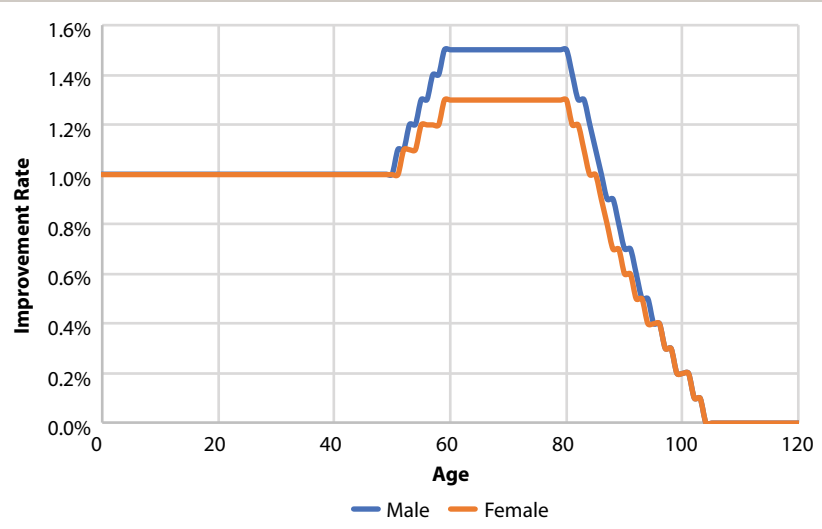



**Figure 2: Forecasted Mortality Improvement Rates**




Source: Society of Actuaries 2012 Individual Annuity Mortality Table (scale G2).

can have significant implications on the funding status for retirees. This effect is illustrated in Figure 1, which includes the results of a time value of money calculation where a flat change in the retirement period is assumed (one year, two years, or three years) based on the current forecasted retirement period (five years to 30 years in one-year increments), assuming a real discount rate of 3 percent.

A change in the expected retirement duration is greatest for households with shorter expected retirement durations, like older households. This is intuitive to some extent, since a three-year increase is a larger change for someone with only a five-year expected retirement versus 30 years. Younger households are likely best positioned to manage unexpected changes in mortality rates because they have a greater ability to adapt. For example, younger households can choose to increase savings rates, attempt to retire later, adjust retirement spending expenditures, potentially work in retirement, etc. In contrast, older households, especially those already some ways into retirement, have significantly less ability to change course. While the implications associated with unexpected change in the duration vary by household, it can be significant, and should therefore be incorporated into the portfolio creation process.

## Longevity Risk

Longevity risk is perhaps the greatest risk faced by retirees given its impact on the retirement liability. Retirement will last over 40 years for some households, but only a few years for others. Financial planners commonly incorporate uncertain mortality into financial plans by selecting a retirement period that is longer than the true life expectancy that the household has a relatively low probability of outliving, such as 10 percent. This approach can lead to over-saving or under-spending (Blanchett and Blanchett 2008) and still subjects the household to mortality tail risk, should the household survive beyond the forecasted period.

Life expectancies have increased considerably over the past few decades and are generally expected to continue increasing into the future. Decreasing mortality rates, or increased life expectancies, is an effect commonly referred to as "improvement." Figure 2 provides some context as to the forecasted mortality improvement rates based on the Society of Actuaries 2012 individual annuity mortality table[2] (scale G2).

Forecasted mortality improvement rates vary by age. For example, males and females between the ages of 60 and 80 are expected to see the greatest improvements in mortality weights based on the mortality table assumptions in Figure 2, while the oldest individuals (85 and older) are expected to see the lowest.

The mortality improvements are expected to be cumulative in nature. For

example, assuming an improvement rate of 1.5 percent (the rate for a 65-year-old male), if the mortality rate in a given year was 1 percent (approximate probability of death at age 65), the mortality rate would be expected to decline to 0.86 percent in 10 years.

Improvement can have a significant impact on the expected duration of retirement. For example, life expectancy for a 65-year-old male in 2015 is 21.74 years, based on the Society of Actuaries 2012 individual annuity mortality table. This is projected to increase by 2.54 years to 24.28 years in the year 2045. This means someone who is currently 35 years old and expects to retire in 30 years (at age 65) would be expected to have to fund a retirement that is approximately three years longer than someone retiring at the age of 65 in 2015.

Since mortality improvements are widely known, the implications of improvement have already (theoretically) been incorporated into financial planning expectations and market prices. Significant retirement planning considerations emerge, though, when mortality expectations differ from reality.

Evidence suggests errors in these forecasts are relatively common, even at the population-level. For example, a study by the U.K. Office of National Statistics[3] showed that future estimates of longevity in the U.K. have been consistently too low in successive forecasts, and that the errors were large. These forecast errors are not isolated to a single country, and have been global in nature (Tuljapurkar, Li, and Boe 2000).

Unexpected changes in mortality rates could be sudden or gradual, and mortality rates could improve in a variety of ways. The greatest cause of death in the United States for individuals age 70 or over in 2017 was cardiovascular disease (37.6 percent of deaths), which are deaths owing to circulatory problems such as heart attacks and strokes, followed by cancer (22.5 percent), dementia (14 percent), respiratory disease (8.2 percent), lower respiratory infections (4 percent), and kidney disease (3.5 percent).[4]

The impact of unexpected changes in mortality rates would likely vary across households based on health level, region, income, etc. Research by PGIM[5] suggested that a cure for all forms of cancer would likely have the greatest mortality improvement for middle-aged individuals, but less of an impact on older individuals since they are more susceptible to other ailments. PGIM also noted that younger individuals are most likely to benefit from anti-aging genetic treatments since it will likely take many years for the most promising anti-aging research to move from pre-clinical research to successful clinical trials and ultimately to successful application on humans.

This paper is primarily focused on the implications associated with unexpected improvements in mortality. However, it's also possible that mortality rates increase in the future (i.e., the expected duration of retirement would decrease). For example, if the percentage of the population that is overweight or obese continues to increase, or some new disease were to emerge, it's possible current life expectancy forecasts could be too optimistic. Should this occur, required retirement savings would decrease on average. In theory, the truly optimal retirement portfolio from a liability-matching perspective would decrease in value as well. Although this may seem counterintuitive, the goal of LDI approaches is not wealth maximization, rather it's to maximize the probability of an investor accomplishing the goal.

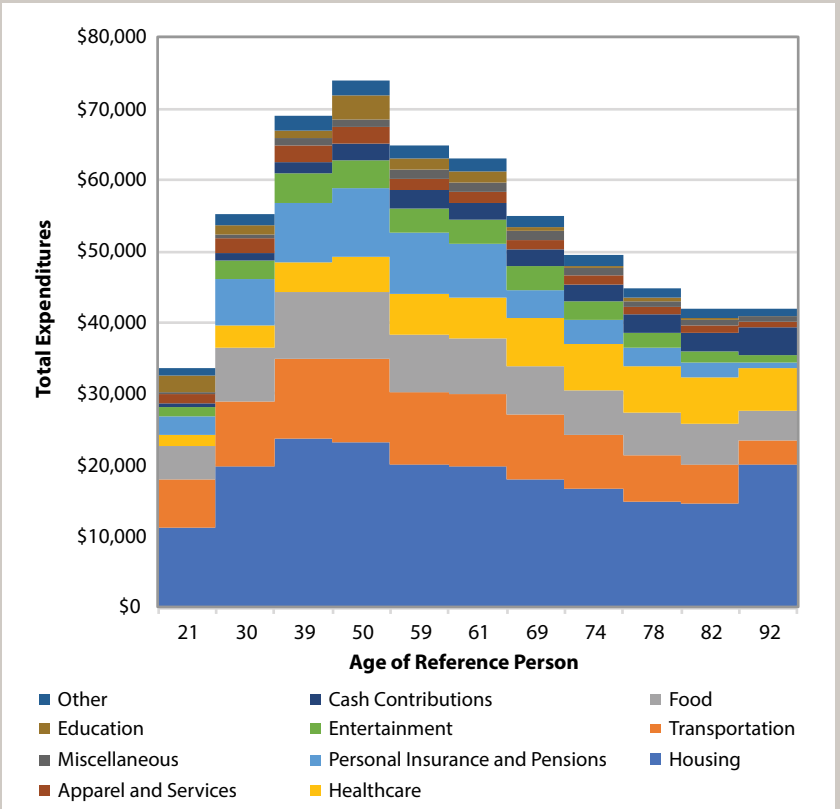
## The Market for Mortality-Linked Investments

The optimal investment to hedge changes in mortality rates would be directly linked to changes in expected, or realized, changes in mortality rates. The ability of other investments, such as publicly traded stocks, to capture the liability implications of unexpected changes in mortality rates is unclear, since the hedge is only implicit in nature.

Relatively few mortality-linked investments are available today, and those that do exist are not widely used or actively in demand—even among pension plans; nor are they practical for use in household (or retail) portfolios, given the lack of liquidity, transparency, standardization, etc., in the market. Therefore, it is unlikely mortality-linked investments will be available—or attractive—for use in household portfolios for the foreseeable future. This section provides a brief overview of the market for mortality-linked investments.

One approach to directly hedging longevity risk would be to take a position that has the opposite risk exposure. For example, an insurance company can theoretically hedge its longevity risk exposure from selling annuities by selling an equivalent amount of life insurance. Assuming the attributes and risk exposures of these two groups were identical, the risks associated with unexpected changes in mortality would be eliminated, because any money lost through additional annuity payments (e.g., life expectancies increase) could be made up from additional life insurance premiums, and vice versa. In reality, such perfect hedges are rare and theoretically available to relatively few investors (e.g., not households or pensions). Even insurance companies that sell both life insurance and annuities can have a difficult time matching the risks of the respective groups. For example, many life insurance policies are temporary (term) policies, which typically lapse well before retirement. Products focused on the longevity curve, such as deferred income annuities/

**Figure 3: Average Household Expenditures by Age**




Source: Bureau of Labor Statistics (bls.gov/cex/tables.htm#crosstab)

longevity insurance, can be especially difficult to hedge.

Mortality bonds were one of the first publicly available mortality-linked investments. The first mortality bond was issued by Swiss Re in December 2003, where the principal would be reduced had there been a catastrophic mortality event during the life of the bond, thereby reducing Swiss Re's exposure to extreme mortality risk.

Other examples include a 25-year longevity bond announced in November 2004 from Paribas, and the European Investment Bank (EIB) for U.K. pension funds with exposures to longevity risk where annual coupon payments would be tied to the realized survival rates for some English and Welsh males.[6]

The first publicly announced longevity derivative transaction between investment bank J.P. Morgan and Lucida, a U.K.-based insurer, took place in January 2008 and was unique because it hedged the value of the annuity liability, not the actual payments.

Despite these developments, several issues will likely pose headwinds to future growth in the mortality-linked investment space, such as a general lack of demand, lack of a balanced market, and matching/pricing considerations at the household level.

Speaking of demand, defined benefit (DB) plans would seem to be an ideal investor for mortality-linked investments. The large number of beneficiaries in DB plans limits the plans' exposure to the idiosyncratic longevity risk faced by households (i.e., the potential to live significantly longer than average), yet these plans still are exposure to uncertain changes in future mortality rates, which could significantly jeopardize the plan's funded status.

While the desire of plans to offload the risk in the pension risk transfer/buy-out market appears to be growing (a recent LIMRA study noted an increase in pensions very interested in transferring the risk from 32 percent in 2015 to 44 percent in 2018[7]) the market is still relatively small, and there is still relatively little interest in mortality-linked investments.

For example, a recent survey by Aon[8] of individuals responsible for managing DB pension schemes in the U.K. noted only 6 percent of respondents had already implemented or were currently implementing some type of longevity management exercise, such as longevity swaps/insurance; and 56 percent of respondents were not considering such a risk reduction technique at all. In contrast, 67 percent of respondents had already implemented or were currently implementing some type of close matching asset risk reduction exercise.

The lack of a balanced market will likely also serve as an impediment for the growth of mortality-linked investments. The vast majority of potential investors in mortality-linked investments would seemingly be interested in offloading or shorting the risk, not taking it on.

Companies that could potentially benefit from a longevity increase, like pharmaceutical companies, nursing homes, etc., could hypothetically hedge against a potential decline in mortality rates or revenue by taking short positions on longevity risk, but for a variety of reasons, these companies would be unlikely to enter the market in a material way, if at all, when gains would be realized. Would shareholders want the company to hedge the risk? Even if these companies did start taking a material interest, there would still be far more longevity sellers than buyers.

And while countries have been

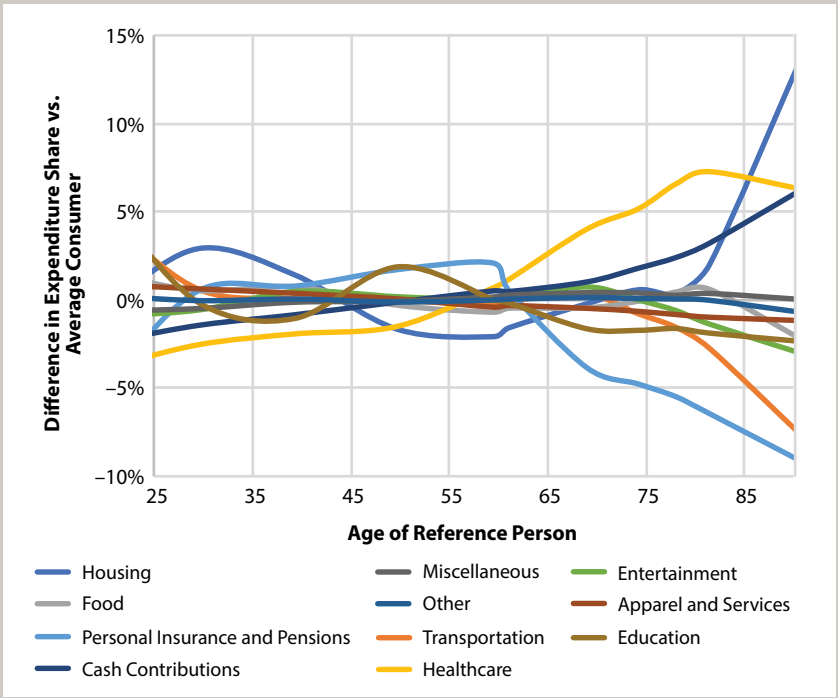
suggested as a potential entity that could issue longevity bonds, they already have exposure to longevity risk through public pensions, so it seems unlikely they would want to amplify their longevity risk exposure.

Even if a variety of mortality-linked investments became more popular, it is not clear to what extent they would be attractive for individual household portfolios given concerns around general structure, costs, risk-matching, etc. For example, longevity bonds typically have maturities that extend 20-plus years with complex provisions that vary by issue. The long duration of these bonds introduces other risks, such as interest rate risk, counterparty risk, and complicates the potential hedging benefits.

There are also concerns regarding the ability of specific investors to hedge their unique longevity risk, commonly referred to as "longevity basis risk." In theory, investors would not necessarily be interested in hedging changes in mortality rates for an entire population if that group is not necessarily representative of their risk exposures. For example, wealthier Americans, who have the vast majority of retirement savings, tend to have longer life expectancies than the "average" American (Chetty et al. 2016), and therefore, any type of mortality-linked investment targeted toward these investors would likely need to be based on their expected mortality rates.

There are also questions surrounding the potential costs of such mortality-linked investments, as well as liquidity and transparency—or how payouts will be determined. Therefore, although there is a clear potential benefit from mortality-linked investments, the extent to which viable options will become available is not clear. As a result, in the near term, any type longevity portfolio will likely need to be constructed using assets that are not directly linked to longevity.

**Figure 4: Difference in Average Household Expenditure Share Vs. Average Household**




Source: Bureau of Labor Statistics

Relatively little research exists on how to develop such longevity portfolios from more traditional assets. One resource available is a 2016 whitepaper by PGIM titled, "A Silver Lining: Investment Implications of an Aging World," which explores the types of investments that may be most attractive as life expectancies increase, but does not explicitly address unexpected changes in mortality.[9]

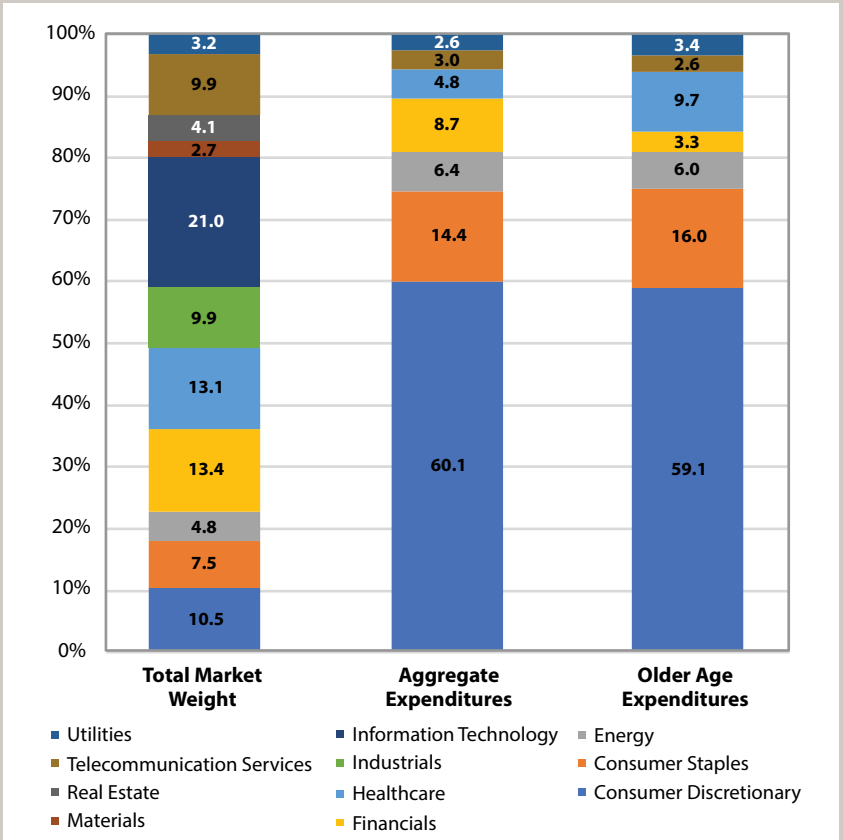
One investment available today that explicitly targets the risks relating to longevity is Janus Henderson's Long-Term Care ETF (OLD). This ETF was introduced in June 2016 and is based on the Solactive Long-Term Care Index, which tracks the performance of companies positioned to profit from providing long-term care to the aging population.[10] Acceptance and usage of the ETF is very small though, with total assets of $36.8 million as Jan. 23, 2020.

## Understanding Household Expenditures

The first step to building a longevity portfolio is understanding how spending patterns of older households differ from the average household. Figure 3 includes average expenditure information on U.S. households grouped by the average age of the reference person, based on the 2017 Consumer Expenditure Survey from the Bureau of Labor Statistics. The average age of the reference person across all consumer units is 51.

The most notable effect with respect to total retiree expenditures in Figure 3 is the reduction in total spending at older ages. Households with a reference age of 69 spend $54,995 annually, while households with a reference age of 81.5 only spend $41,850, which is a 24 percent reduction in expenditures. While this dataset is cross-sectional, the reduction in household expenditures by age has been noted in panel datasets (Blanchett 2014).

**Figure 5: Market Capitalization Weights by Sectors Vs. Expenditure Weights by Sector**




Source: Morningstar Direct, Bureau of Labor Statistics

While most expenditures decrease in absolute terms at older ages, there are notable exceptions, for example cash contributions increase considerably by age, and spending on housing and healthcare remain relatively constant after age 65.

The relative changes in expenditures by age are clearer in Figure 4. For example, the growing share of healthcare, cash contributions, and housing is notable, while the decline in transportation and personal insurance and pensions is more apparent. The increase in housing costs is an example of how significant changes within the respective broad expenditure group are not necessarily evident at the broad expenditure level. For example, young households allocate a significantly greater portion of total housing expenditures to mortgage payments, while older households allocate a much greater portion to repairing and maintaining the house since the home is paid off in many cases. This suggests the costs related to paying for the house may disappear at older ages if the mortgage is paid off, but other costs, such as real estate taxes, insurance, etc., are still present. Also, certain expenses increase as the individual is no longer able or willing to care for the home.

Other, more subtle differences in expenditures are evident across different cohorts, such as income groups. For example, looking at separate expenditure crosstabs, we see that among households over age 65, when sorted by income before taxes, the relative share of food, housing, and healthcare declines (in percentage terms) as incomes increase, while the allocation to things like personal insurance and pensions increase.

## Building the Longevity Portfolio

Retiree expenditures provide some perspective as to what types of industries stand to benefit from changes in mortality rates. However, household spending weights are not reflective of the actual value of respective market sectors when viewed on a market capitalization basis.

Figure 5 provides some perspective on this effect by comparing the weights to the various U.S. sectors, either based on the market capitalization of all U.S.-listed, publicly traded securities as of Sept. 4, 2019, based on data from Morningstar Direct, or the respective expenditure weights, like those in Figure 4.

The aggregate sector-level expenditures weights in Figure 5 were determined at a level below the weights included in Figure 4, and were based on the respective industry, according to the MSCI Global Industry Classification Standard (GICS) system (msci.com/gics). Note that in Figure 5, each expenditure was mapped to a single industry or industry group, which is a subjective exercise.

Figure 5 demonstrates that certain industries that feature prominently in the market capitalization weighted portfolio have little or no weight in an expenditure weighted portfolio—industries such as information technology and materials. Although it is likely that growth in these sectors would affect the economy, the extent a retiree's portfolio needs to have exposure to weapons manufacturers, for example, is debatable.

Creating a portfolio that does not have exposure to the complete market could result in lower returns (or risk-adjusted returns), in theory. For example, research on the potential cost/benefits of ESG/SRI investments is relatively inconclusive and suggests if there

**Table 1: Most Loved Brands by Generation**

| Rank | Gen Z (18 to 21) | Millennials (22 to 37) | Gen X (38 to 53) | Boomers (54 to 72) |
|---|---|---|---|---|
| 1 | Google | Netflix | Google | UPS |
| 2 | Netflix | Google | Amazon | Home Depot |
| 3 | YouTube | Amazon | Netflix | U.S. Postal Service |
| 4 | Amazon | YouTube | UPS | Lowe's |
| 5 | Oreo | Target | Home Depot | FedEx |
| 6 | PlayStation | Nintendo | Hershey | Amazon |
| 7 | Walmart | Dollar Tree | Cheerios | Hershey |
| 8 | Target | Samsung | U.S. Postal Service | AAA |
| 9 | Doritos | Android | Android | Tide Detergent |
| 10 | Nintendo | UPS | FedEx | Cheerios |
| 11 | Chick-Fil-A | U.S. Postal Service | Tide Detergent | Crest |
| 12 | Nike | Gatorade | PayPal | Ace Hardware |
| 13 | Marvel Studios | Dove | YouTube | The Weather Channel |
| 14 | Spotify | Doritos | The Weather Channel | Campbell's Soup |
| 15 | Instagram | FedEx | Dove | Reynolds Wrap |
| 16 | Pizza Hut | PlayStation | Dollar Tree | Betty Crocker |
| 17 | Sprite | Walt Disney | Samsung | Subway |
| 18 | Dunkin' Donuts | Home Depot | Lowe's | Clorox |
| 19 | Dollar Tree | Pixar | Levi's | Dollar Tree |
| 20 | Skittles | Colgate | Doritos | Kellogg's |

Source: Morning Consult's Most Loved Brands in America 2019 (morningconsult.com/most-loved-brands-2019)

are costs associated with such strategies, they may be relatively minor and offset by the intrinsic benefits associated with the approach (Revelli and Viviani 2015). The potential lower returns an investor in a longevity portfolio should be willing to accept given its potential hedging ability is addressed in the next section.

While the true, optimal approach to develop a longevity portfolio is beyond the scope of this paper (and expertise of the author), it is worth briefly exploring some considerations for developing the portfolio at the sector level. Two sectors that would likely be featured prominently in any kind of longevity portfolio would be: (1) consumer spending (i.e., consumer discretionary and consumer staples), given its relatively large share of retiree expenditures; and (2) healthcare, given the unique role of healthcare expenses for retirees.

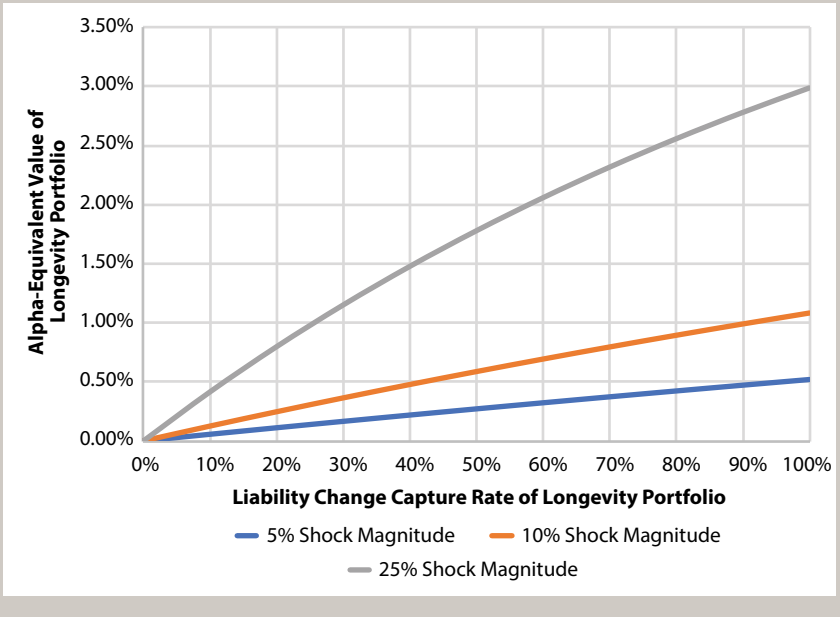
**Consumer spending.** Consumer discretionary spending is the largest of expenditures for all households. While households of course have the ability to decrease spending on certain discretionary items, preferences tend to become increasingly inelastic at older ages, something explored in-depth by Karani and Fraccastoro (2010), among others. This suggests that products and services currently consumed by the elderly (or are likely to be in the future, as generational preferences evolve), would be more likely to benefit, should life expectancies increase. This creates important implications for companies within different industries. For example, Cadillacs and Buicks are considerably more popular with older individuals than Mazdas and Volkswagens.[11]

It is difficult to gauge consumer preferences without detailed knowledge of each company and its customer base, and limited public data is available on this specific topic. A metric such as "average customer age" would be an incredibly useful metric to understand customer demographics; unfortunately, such data does not exist. A close approximation would be something like brand preferences. For example, Morning Consult conducted a survey in 2019 and determined the "most loved" brands in America. The top 20 brands by generation are shown in Table 1.

While there are similarities across generations, like a high affinity for Amazon.com, there are also notable differences. Nine of the most loved companies by boomers (ages 54 to 72) do not appear in any of the other generational lists: AAA, Ace Hardware, Betty Crocker, Campbell's Soup, Clorox, Crest, Kellogg, Reynolds Wrap, and Subway. Understanding differences in preferences among generations is an essential component to building an effective longevity portfolio and likely requires specialized, detailed focus in the consumer spending space.

**Healthcare.** Healthcare is another sector that would be significantly affected by an increase in life expectancies given the relatively inelastic demand for healthcare-related goods and services. Older Americans consume a disproportionate share of healthcare. For example, Fuchs (1998) noted that individuals aged 85-plus consume twice as much healthcare per person as those aged 75 to 84 and three times as much as those aged 65 to 74. Estimates

**Figure 6: Alpha-Equivalent Value of a Longevity Portfolio**




on end-of-life medical spending have varied, but have been estimated at 10 percent of overall lifetime spending in the last calendar year of life (including long-term care), on average, and 20 percent in the last three calendar years (French et al. 2017).

Within the healthcare space it would be possible to invest in either or both companies that: (1) could create solutions that increase longevity, like curing cancer, and (2): are more likely to capture the benefits, like an increased demand for their product or services. While it would be difficult to predict the company or companies that will discover the cause of the longevity solution, these companies should benefit more from longevity gains relative to the firms gaining incremental demands from people living longer due to strong pricing power associated with incremental life years gained. A typical quality-adjusted life year (QALY) gained can achieve pricing of $100,000[12] with gross margins likely well over 90 percent, leading to significant valuation expansion for the company creating the expansion of life.

Hospitals would seem to be the greatest beneficiary of higher healthcare spending dollars, however the payer dynamics associated with hospitals can reduce the economic profits below their cost of capital. Additionally, most hospitals in the U.S are private, which prevents the ability to invest directly. Other countries have different payer dynamics and may be more attractive if longevity gains are realized globally. Within the drug space, the ideal companies would have drugs focused on older patients and would eliminate drug companies with a high exposure to pediatric vaccines. Other industries that should benefit would include orthopedic device companies, which make hip and knee replacement parts; and cardiac device makers, which make pacemakers, replacement heart valves, and left ventricular assist devices, because even if we manage to extend life spans, bodies will likely still wear down in old age.

**Additional sector considerations.** Other industries and companies could also potentially benefit from increased life expectancies, including:

*Information technology*: companies developing solutions for the elderly, such as apps to help pay bills, monitor health, etc.

*Real estate*: REITs focused on specific industries, such as healthcare.

*Financials*: companies developing financial products or solutions geared toward the elderly, such as those involved with reverse mortgages or other products to help households fund retirement.

*Industrials*: companies developing transportation solutions that keep seniors mobile, like self-driving cars.

Longevity portfolios would likely differ significantly by provider. Longevity portfolios are fundamentally active investment strategies because they require detailed knowledge of household spending, brand/company preferences, product development, etc.

## Is the Benefit Worth the Potential Cost?

Given the complexities associated with developing and managing a longevity portfolio, there could be additional, marginal "costs" associated with running such a strategy compared to investing in a low-cost index fund. Such costs could be lower forecasted returns due to not owning the market, a higher expense ratio compared to lower cost market capitalization investment options, or some combination of these. An analysis was performed to determine the "value" of a longevity portfolio from a cost/fee perspective.

The analysis focused on the impact of an unexpected change in mortality on the funded status of the retiree, as measured by the funded ratio. The funded ratio is an actuarial measure of how on track an investor is to accomplish a goal and is relatively popular in the defined benefit pension space. In a single metric, the funded ratio conveys the funded status of an investor. For a retiree at retirement, the funded ratio would be calculated by dividing the total value of the assets (which would include total accumulated wealth plus the mortality-weighted net present value

of all future expected inflows like Social Security retirement benefits) by the total retirement liability, which would be the mortality-weighted net present value of future outflows, or the annual retirement need.

A funded ratio below 1 would imply the retiree does not have enough assets to fund the retirement liability. A funded ratio of 1 would imply the retiree is perfectly funded, and a funded ratio greater than 1 would imply the retiree is overfunded.

The analysis assumed there was an instantaneous improvement in mortality, and compared the benefit of a longevity portfolio focused on hedging this potential change, to a regular portfolio not focused on hedging this potential change. The analysis assumed the expected return and risk of these two portfolios was the same; however, it's possible the longevity portfolio could have a lower risk-adjusted return due to its unique exposures to the potential longevity shock, which is a key part of what the analysis tries to address (i.e., how much lower the expected return of the longevity portfolio could be for a retiree to be indifferent between the two portfolios).

The analysis used the constant relative risk aversion utility function, shown in Equation 1, where the amount of utility ($U$) received by the retiree is assumed to vary depending on assumed funded ratio ($FR$) and level of investor risk aversion ($\gamma$), to quantify the potential benefit of the longevity portfolio.

$$U(FR) = \frac{FR^{1-\gamma}}{1-\gamma} \qquad [1]$$

The analysis assumed the individual's initial funded ratio (i.e., before the longevity shock) equaled 1, which means the total assets were equivalent to the liability. The analysis assumed an instantaneous improvement in mortality, where the value of the liability was assumed to change or increase by some percentage ($\Delta L$). The values of the assets may also change, based on some combination of the change in liability ($\Delta L$) and the percentage of the liability change that is captured ($C$) by that portfolio.

For example, if there is a 10 percent increase in the liability and the respective portfolio were to capture 50 percent of the change, the assets would increase by 5 percent. This increase in assets obviously partially offsets the increase in the liability. The probability of the mortality shock occurring in a given period ($S_P$) was incorporated as well. The analysis period can be assumed to be annual.

The value of the longevity portfolio was estimated in certainty-equivalent alpha terms ($\alpha LP$), by subtracting the certainty-equivalent funded ratio of the market portfolio ($CE_{MP}$), calculated using Equation 2:

$$CE_{MP} = \left( S_P \left( \frac{(1+(\Delta L * C_{MP}))}{1+\Delta L} \right)^{1-\gamma} + (1-S_P)(1^{1-\gamma}) \right)^{\frac{1}{1-\gamma}} \qquad [2]$$

from the certainty-equivalent funded ratio of the longevity portfolio ($CE_{LP}$), calculated using Equation 3:

$$CE_{LP} = \left( S_P \left( \frac{(1+(\Delta L * C_{LP}))}{1+\Delta L} \right)^{1-\gamma} + (1-S_P)(1^{1-\gamma}) \right)^{\frac{1}{1-\gamma}} \qquad [3]$$

as noted in Equation 4:

$$\alpha LP = CE_{LP} - CE_{MP} \qquad [4]$$

This approach provides a closed form solution to estimate how much more an investor should be willing to pay for the longevity portfolio in annual basis points form, or at what additional cost for the longevity portfolio the retiree would be indifferent between the two portfolios.

Figure 6 includes the results of such calculations, where the probability of a mortality shock ($S_p$) was assumed to be 10 percent, the market portfolio capture rate ($C_{MP}$) was 0 percent, and the funded ratio risk aversion coefficient ($\gamma$) was 4. With these parameters, we can test shock magnitudes ($\Delta L$) of 5 percent, 10 percent, or 25 percent, which roughly corresponds to the 30-year, 20-year, and 10-year retirement horizons assuming a three-year increase in the retirement period based on the values in Figure 2 and longevity portfolio capture rates ($C_{LP}$) from 0 percent to 100 percent.

The value of the longevity portfolio (i.e., the alpha equivalent value) increases for higher shock magnitudes and the better job the longevity portfolio does actually capturing the shock itself. For example, if we assume the longevity portfolio can capture 50 percent of the longevity shock, the alpha-equivalent values would be 27 bps, 59 bps, and 178 bps for shocks of 5 percent, 10 percent, and 25 percent, respectively.

Certain variables have an intuitive impact on the results, whereby alpha-equivalent values tend to be higher the greater the relative capture rate between the longevity and market portfolio, the greater the shock probability, the higher the shock magnitude, and the greater the risk aversion of the investor (with respect to changes in funded ratios). Overall, these results suggest that even if a longevity portfolio strategy has a higher expense ratio than a traditional portfolio approach (i.e., a lower risk-adjusted return) it may still benefit the investor, depending on the preferences, situation, and expectations of that investor.

## Additional Considerations

A number of additional considerations exist when building a longevity portfolio and potentially using it for a client, including risk appropriateness/diversification, benchmarking, and longevity as an investment factor.

**Risk appropriateness/diversification.** The longevity portfolio detailed here is relatively aggressive, with a focus on using individual stocks. Relatively few retirees allocate 100 percent of their financial assets to stocks; therefore, it is likely the longevity portfolio would only be one sleeve of a larger portfolio. A longevity portfolio could be paired with other asset classes that are designed to hedge unexpected changes in mortality rates, and are typically considered more attractive for retirees, on average, such as inflation-linked bonds for fixed income or REITs—in particular, REITs focused on the healthcare industry (Idzorek and Blanchett 2019).

**Benchmarking.** The goal of a longevity portfolio is to generally capture the equity risk premium as well as hedge uncertain mortality risk. This unique objective could create issues around benchmarking, consistent with other goals-based approaches. In theory, a longevity portfolio constructed entirely of equities could be placed into a generic style group, like a Morningstar Category, but such a grouping approach may not accurately reflect the risk exposures of the fund. While there are more sector-focused fund groups, like healthcare, even with a given sector there could be significant differences in exposures if the goal is to focus on companies that could benefit from changes in unexpected mortality. Even if some type of representative benchmark index or category group for longevity portfolios were created, there would likely be considerable differences across approaches.

**Longevity as an investment factor.** Investment factors have become popular both in the finance literature and in investment products, like fundamental ETFs. In theory, longevity risk could become a factor if it was possible to quantify the exposure of a given company or investment to longevity risk and apply this model to all or most securities. Given such a model, you create long and short exposures across securities and develop a longevity factor. While it would be possible to create such a factor using just generic sector exposures, as noted in Figure 5, a true longevity factor would likely require a deeper understanding of individual company risk exposures. To the extent such a factor and its underlying methodology were publicly available, it could enable potentially a low-cost way to gain exposure to longevity risk as well as serve as a benchmark for other similar respective strategies.

## Conclusions

Retirement is the largest liability most households will ever fund, yet the vast majority of retirement portfolios either only implicitly consider the unique risks associated with the retirement liability or ignore the risks completely. While annuities are likely the best way to hedge longevity risk, they are relatively unpopular, resulting in funding strategies that largely rely on investments like stocks and bonds.

This paper introduced the concept of a "longevity portfolio," which is an investment approach designed with the explicit purpose of managing the costs associated with unexpected improvements in mortality. The ideal investments for a longevity portfolio would be those directly linked to changes in mortality, yet such securities are incredibly rare and unlikely to be attractive options for households for the foreseeable future for a variety of reasons.

The ability of a longevity portfolio to comprise publicly traded stocks to hedge unexpected changes in mortality is unknown. However, the concept of a longevity portfolio represents the next step in retirement investing because it places the fundamental objective of the retirement portfolio—funding retirement—at the forefront. Future research will hopefully explore this topic more and result in portfolios explicitly designed to help retirees fund retirement increasing in popularity. ■

## Endnotes

1. As noted in Franco Modigliani's Nobel Prize acceptance speech in 1985, nobelprize.org/prizes/economic-sciences/1985/modigliani/lecture.
2. See actuary.org/sites/default/files/files/publications/Payout_Annuity_Report_09-28-11.pdf.
3. See the July 2015 U.K. Office for National Statistics whitepaper, "National Population Projections Accuracy Report," available at ons.gov.uk/file?uri=/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsaccuracyreport/uknppaccuracyreport2015tcm774127221.pdf.
4. See ourworldindata.org/causes-of-death.
5. See the 2016 PGIM paper, "A Silver Lining: The Investment Implications of an Aging World," available at institutionalinvestor.com/images/416/Longevity_paper-3-16-16.pdf.
6. See the April 2012 International Monetary Fund report, "The Global Financial Stability Report: The Financial Impact of Longevity Risk," available at imf.org.
7. See September 2019 data reporting from LIMRA at limra.com/en/newsroom/industry-trends/2019/limra-secure-retirement-institute-finds-40-percent-of-plan-sponsors-are-very-interested-in-pension-risk-transfer-transactions.
8. See the 2018 Aon whitepaper, "Professional Pensions: Research Study into the Challenges DB Schemes Pose to Finance Team," available at aon.com/getmedia/d03e7964-9ad5-4c7d-bfec-e4132f3442e9/Pensions-from-the-perspective-of-a-finance-professional.aspx.
9. See endnote No. 5.
10. See the Solactive Long-Term Care Index fact sheet at solactive.com/wp-content/uploads/solactiveip/en/Factsheet_DE000SLA17X0.pdf.
11. See the March 2012 HIS Markit report, "Buick

Goes Against Trend and Attracts Younger Buyers," available at ihsmarkit.com/research-analysis/buick-goes-against-trend-and-attracts-younger-buyers.html.

12. See the September 2019 commentary by CVS Health's Troy Brennan, Ph.D., "Time for Action on Drug Prices," available at payorsolutions.cvshealth.com/insights/time-for-action-on-drug-prices.

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