

# **Recreating Sustainable Retirement**

**Resilience, Solvency, and Tail Risk**

EDITED BY

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## Chapter 12

# **Risk Budgeting and Longevity Insurance: Strategies for Sustainable Defined Benefit Pension Funds**

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*Amy Kessler*

The extreme losses incurred in defined benefit (DB) pension plans during the financial crisis have called into question the conventional approach to managing pension risk. In the aftermath of the financial crisis, many plans have closed and stopped accruing benefits for new or existing members. Closing a plan, however, only stems the growth in the pension risk—it does nothing to manage the risk the plan already has. Today, in the wake of unprecedented losses and with a new understanding of longevity risk, open and closed DB plans in the United Kingdom, the Netherlands, the United States, Canada, Switzerland, and other countries continue to search for a new paradigm that manages investment risk, longevity risk, and intergenerational risk.

Investment risk is the risk that asset performance falls short of expected returns. Twice in the past dozen years, plans that maintained a high allocation to risky assets have incurred losses severe enough to overwhelm many plan sponsors. Longevity risk is the risk that plan participants and eligible dependents live longer than expected. While longer life is a welcome development, it is also a significant financial obligation for pension plan sponsors, particularly where the retirement age has remained the same for decades. Intergenerational risk is the risk that current employees contributing to a pension plan will support current retirees at the expense of securing their own future retirement benefits. In most open plans, the number of retired participants is rising much more quickly than the number of working age people contributing to the plan. This raises questions about sustainability and fairness, particularly where pension deficits are acute, the credit quality of the plan sponsor is weak, and life expectancy is underestimated. Current employees contributing to such plans are exposed to the risk that the plan sponsor may not be able to fulfill its future obligations to them.

In today's low interest rate and low-growth environment, these risks are particularly daunting and the failure to manage them is behind the growing funding gap for the many DB pensions. The key question is how to develop the strategies and solutions that will help pension funds regain and maintain a path toward a stable and sustainable future.

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A ‘DB Pension Sustainability Model’ will combine techniques that already exist to achieve more predictable outcomes and manage risk within the plan sponsor’s financial wherewithal to absorb losses. The goal is to create a new paradigm for DB risk that draws from the best available practices in risk budgeting, asset management, and insurance. One possible approach is described in this chapter and it includes three components.

First, sustainable risk budgeting involves measuring the key sources of risk that a pension plan has in order to quantify potential losses, identify areas where risks compound each other, and establish a targeted level of potential risk of loss from which the plan and its sponsor could recover over the medium term.

Second is a sustainable asset management approach. With its risk budget in place, a pension plan can chart a course for a lower risk future, shedding the risks that are unrewarded (such as interest rate risk) and creating the opportunity to take risk that is rewarded (such as credit and exposure to equities and alternatives), all within a sustainable risk budget. Also, custom liability-driven investing (LDI), alternative fixed income investments, and absolute return strategies are among the key changes pension funds can make. As asset management choices evolve, a key paradigm shift takes place, bringing the liabilities squarely into the equation to choose assets designed to support the liabilities. The overall goal is a lower risk, lower volatility portfolio that creates a stable base for risk management and a good expected return relative to its risk of loss in funded status.

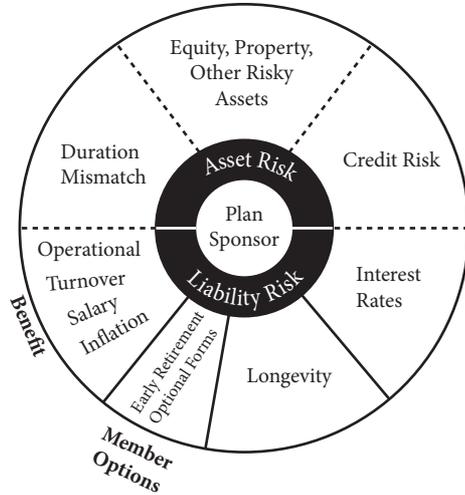
Finally, longevity insurance can be used to cover a DB plan’s most significant demographic risk and achieve three key objectives: (a) to create a known and knowable future obligation and ease the challenge of managing assets against unknown future liabilities; (b) to protect the solvency of the pension fund (and its sponsor) and secure the promises made to plan participants in the event of unexpected longevity; and (c) to address the impact of intergenerational risk on current employees in the event of increasing obligations to retirees.

These strategies go hand in hand with the ability to increase the normal retirement age as healthy life expectancy extends, and this approach can put pension funds on a path to a more sustainable future. To succeed, the DB Pension Sustainability Model must enhance retirement security for plan participants, include a robust safety net for disabled workers to retire early, and be flexible enough to adapt to the risk tolerance and financial wherewithal of plan sponsors of varied size, credit quality, and sophistication.

In what follows, we describe an approach to the DB Pension Sustainability Model. We look forward to a vibrant discussion of these ideas as the pension industry focuses on helping individuals and institutions prepare for a longer retirement.

### **The Nature of Pension Risk**

A DB pension is a promise to pay monthly retirement benefits to participants for as long as they live, no matter what happens to the assets. Plan sponsors who have



**Figure 12.1.** DB plan sponsors are surrounded by risk.

*Note:* Categories of asset and liability risks for sponsors of DB plans.

*Source:* Author's illustration.

made these promises are surrounded by risk. The risk dial in Figure 12.1 shows the key sources of asset and liability risk that are part of the pension promise.

### **Liability Risk**

The liability risks shown on the bottom half of the risk dial in Figure 12.1 include anything that might increase the amount of the benefit the pension fund owes to its members. Longevity risk is the key source of liability risk and is common to all DB plans. Many plans base retirement benefits on final or average salary, creating exposure to salary inflation until plan participants reach retirement age. In addition, some pension plans offer cost of living adjustments to retired participants and for them, inflation risk after retirement compounds the longevity risk exposure. Finally, interest rate risk is included in the liability risks because most pension liabilities are valued by discounting at a high-grade bond yield curve (the ‘liability discount rate’). This approach is consistent with the fact that pension liabilities are often the most senior debt of the plan sponsor.

The liability discount rate a pension fund uses to value its future obligations is the largest driver of the effective rate at which the liabilities grow from one year to the next (the ‘liability growth rate’). Other factors driving the liability growth rate include unexpected improvements in longevity and cost of living adjustments offered to plan participants, if any. Failure to earn the liability growth

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rate on actual invested assets results in an increasing funding gap for the pension plan, with the liabilities growing faster than the assets. This challenge can be particularly acute for pension funds that offer cost of living adjustments to plan participants.

### **Asset Risk—The View for Corporate Pension Funds**

Asset risks are shown on the upper half of the risk dial in Figure 12.1. As long-term investors, the conventional wisdom has been that pension funds should take asset risk, and so investing in equities, private equity, real estate, hedge funds, commodities and other risky asset classes has become the norm. Many pension funds invest 50 percent to 75 percent of their assets in these risky asset classes by choosing asset managers in each desired ‘style box,’ rebalancing periodically to a pre-set asset allocation and measuring performance strictly against benchmarks that are not linked to the liability growth rate. The result of applying this strategy is that the value of the risky assets fluctuates in ways that bear no relation to the liabilities. In effect, with risky assets that have no duration and liabilities that have very long duration, the plan is ‘short duration’ and thus, duration mismatch is also shown on the risk dial as a key challenge for pension funds.

In the generally falling interest rate environment that has prevailed from June 2007 to the present, remaining in a ‘short duration’ position has meant taking a bet that rates would not fall any farther. Unfortunately, with US\$ ten-year Treasury bonds falling in yields above 350 basis points over the same time period (U.S. Treasury 2013),<sup>1</sup> betting on steady or rising rates has been a losing proposition for pension funds, particularly given their present level of underfunding. For pension funds that remain in a short duration position and continue to bet on rising rates, it is useful to note that after the Great Depression, rates remained low (with the ten-year Treasury below 3 percent) for 19 years (Shiller 2013).<sup>2</sup> In light of the severity of the recent financial crisis, as well as the credit contraction and deleveraging that ensued, low interest rates and low growth may persist for a prolonged period.

The key concern in maintaining a high allocation to risky assets and a short duration position is the risk of losing money that is not recovered over a manageable time horizon. Corporate pension funds generally think about this volatility in terms of the plan’s funded status, which is calculated as the market value of assets divided by liabilities discounted at the liability discount rate. When viewed from the perspective of the pension plan’s funded status, it is the extreme volatility of the conventional approach that is causing corporate pension funds the world over to rethink their risk and consider lowering their risk profile to the point where the potential losses are more affordable and more likely to be recovered over the medium term.

The evidence of volatility abounds and is directly linked to two facts. First, the average U.S. pension plan maintains a high allocation to risky assets of 50 percent to 75 percent. Second, the average U.S. pension plan is underfunded and finished



**Figure 12.2.** Funded status volatility.

*Note:* Funded status data depicts the ratio of assets divided by liabilities of U.S. DB plans in the Milliman 100 (Milliman 2013) and U.K. DB plans in the FTSE 100 (Aon Hewitt 2013). Cumulative assets and liabilities are shown aggregated on an accounting basis.

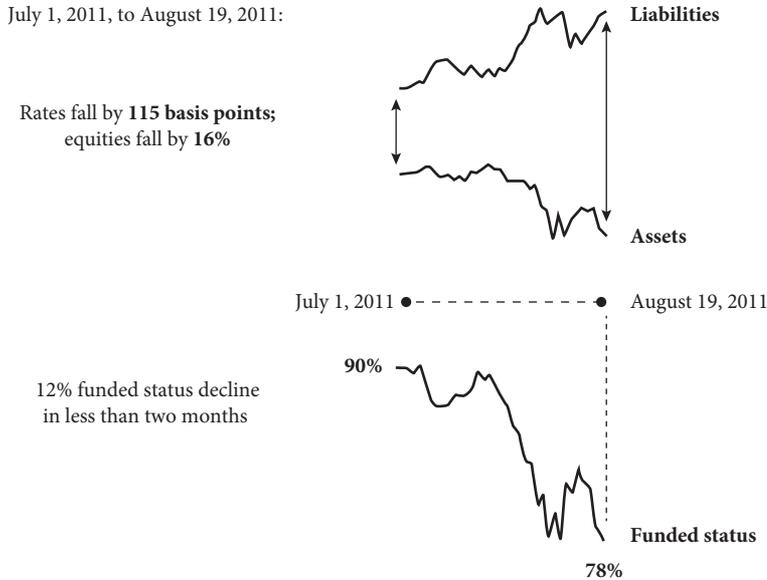
*Source:* Milliman (2013) (Milliman 100 data); Aon Hewitt (2013) (FTSE 100 data).

2012 with assets equal to just 76.4 percent of its liabilities (Milliman 2013). The unfunded liability is leverage and, as in any leveraged investing strategy, gains and losses will be magnified when measured relative to the full amount of the liability.

Figure 12.2 depicts the funded status of U.S. pension plans in the Milliman 100 since the beginning of 2000, and U.K. pension plans in the FTSE 100 since the beginning of 2007. With regard to U.S. pension funds, these data show that from 2000 through 2012, there have twice been losses of over 30 percent in funded status terms. First there was the ‘dot-com bust,’ and then, from 2002 through 2007, U.S. sponsors of DB pension funds in the Milliman 100 contributed over \$245 billion. With help from favorable markets, these U.S. plans returned to good health in 2007, just in time for the financial crisis of 2008, when they lost 30 percent in the downturn. The plans denoted made over \$230 billion in contributions between 2009 and 2012, and they will likely face significant contributions for many more years in order to approach full funding.

One of the most dramatic things about Figure 12.2 is the fact that, despite contributing so much cash from the end of the financial crisis through the middle of 2013, U.S. plan sponsors did not move to a sustained higher funded status. This is precisely because risk-taking remained the norm for the average U.S. plan throughout this period. Most U.S. plans in 2013 combine leveraged, high allocations to risky assets and a short duration position.

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**Figure 12.3.** Scenario—real life!

*Note:* For the period between July 1, 2011, and August 19, 2011, depicts the changes in assets, liabilities and funded status of U.S. DB pension funds in the S&P 500.

*Source:* Aon Hewitt (2013).

Consider the period from July 1, 2011, to August 19, 2011 (depicted in Figure 12.3), when interest rates in the U.S. fell by 115 basis points and equities plummeted 16 percent (U.S. Treasury 2013; Bloomberg 2013).<sup>3</sup> Given the asset and liability mismatch of the average U.S. pension plan in the S&P 500 at that time, their asset and liability values were independently volatile. Liabilities rose dramatically due to the decline in interest rates. In the meantime, assets plummeted because most of the assets were at risk in equities and other risk asset classes.

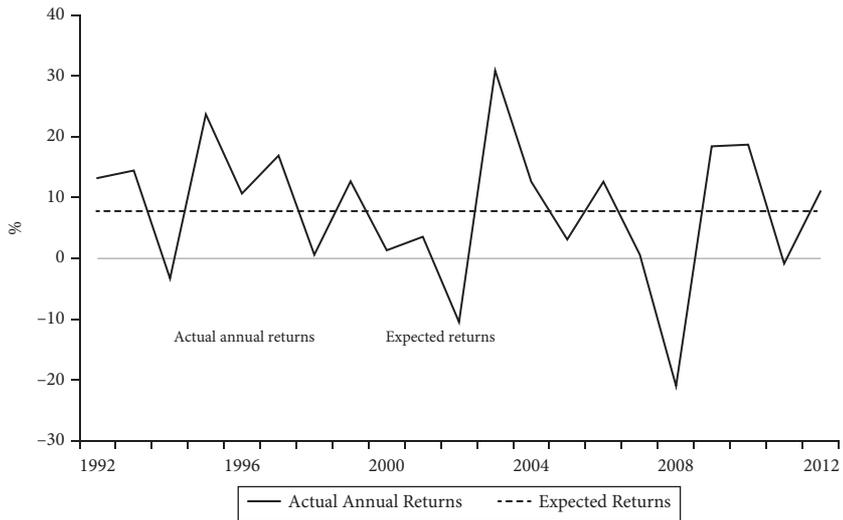
U.S. corporate pension funds have encountered this challenge before. In fact, any time bad news in the economy has caused interest rates and equities to fall simultaneously, the average U.S. pension plan has experienced dramatic losses in funded status. The 34 business days from July 1, 2011, to August 19, 2011, were no exception: with liabilities rising and assets falling, the average U.S. pension plan fell from 90 percent funded to only 78 percent funded (Aon Hewitt 2013).<sup>4</sup> With so much exposure to risk, the rebound one would have hoped for after such a dramatic six-week period was slow to materialize. U.S. plan sponsors ended 2011 only 4 percent higher, with a funded status of 82 percent, and at the end of 2012, there was still no more sustained movement toward higher ground: the average U.S. plan was only 76 percent funded (Milliman 2013).<sup>5</sup>

### Asset Risk for Public Pension Funds

While corporate pension funds in the United States, the United Kingdom, and Canada are focused on funded status, public plans are much more focused on long-term realized returns. Figure 12.4 shows the volatility of this approach over the most recent 20 years, assuming investment in the Russell 2000 Equity Index (Russell Investments 2013) and the Barclays U.S. Aggregate Bond Index (Barclays 2013).

The key goal for most public plans is meeting long-term return expectations, and the data show that a public pension plan investing in this manner will likely achieve its long-term targeted returns (often between 7.5 percent and 8.0 percent) on the assets it has invested. However, U.S. public pension funds rarely have assets invested that are commensurate with their liabilities; for most underfunded plans, the current approach is unsustainable.

A hypothetical U.S. public pension plan might have an expected return on assets of 7.75 percent. Its effective liability growth rate is also at least 7.75 percent of the liabilities, because the future liabilities are discounted at the expected return on assets. This means that a failure to earn at least 7.75 percent on the full amount of the liability will result in a growing funding gap for the pension plan. It is worth noting that the actual liability growth rate may exceed 7.75 percent, once unexpected increases in longevity and benefit cost of living



**Figure 12.4.** Volatility of returns—65 percent equities/35 percent bonds and cash.

*Notes:* The returns depicted are weighted actual returns, assuming 65 percent from the Russell 2000 Equity Index and 35 percent from the Barclays U.S. Aggregate Bond Index. Weighted returns are shown from December 1990 to December 2012.

*Sources:* Author’s calculations from Barclays (2013); and Russell Investments (2013).

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adjustments are included. Figure 12.4 indicates that using a ten-year return on assets of 7.75 percent will lead many to believe that the plan is achieving its target. However, the public pension plan may be only 60–65 percent funded, so it only has 60–65 percent of the assets it needs earning returns. Historical data show that plans can reasonably expect to earn 7.75 percent on the invested assets. But plans can reasonably expect to earn zero percent on the unfunded liability, which can best be thought of as the ‘allocation to air’ in the portfolio. In fact, the unfunded liability represents leverage in the investment strategy. As in any levered investment strategy, gains and losses will be magnified when measured in relation to the liability.

A natural question thus arises: how difficult will it be for this hypothetical public pension fund to overcome the unfunded liability, meet current benefit payments, and maintain or improve funded status? Figure 12.5 shows how daunting this challenge is. With 62.8 percent of the liabilities invested and earning 7.75 percent, and the remainder unfunded and earning zero percent: (a) the plan likely needs to earn 10.9 percent or 11 percent to remain at its present funded status and avoid an increasing funding gap; and (b) without cash contributions to improve the funded status, the plan likely needs to earn 12.7 percent or more on a sustained basis to



**Figure 12.5.** The impact of leverage and the disconnect between assets and liabilities.

*Note:* The return required to maintain or improve the funded status is calculated by Prudential assuming a typical open public plan in the U.S. with cost of living adjustments in its benefits, a starting funded status of approximately 63 percent, and benefit payments that increase by 5 percent per year.

*Source:* Author's calculations.

reach 80 percent funding within ten years. This analysis assumes no unexpected increase in longevity and no periods of higher than expected inflation.

This analysis demonstrates the depth of the public pension crisis in the United States and in many other countries where the leverage in the pension fund requires an unrealistically high realized rate of return in order to avoid an increasing funding gap. It is for this reason that most public pension funds need to consider one further aspect of a DB Pension Sustainability Model—a Sustainable Contribution Strategy that will bring potential earnings on actual invested assets into line with the year-on-year growth in the liabilities.

### **Longevity Risk Is Material and Often Left Out of the Risk Equation**

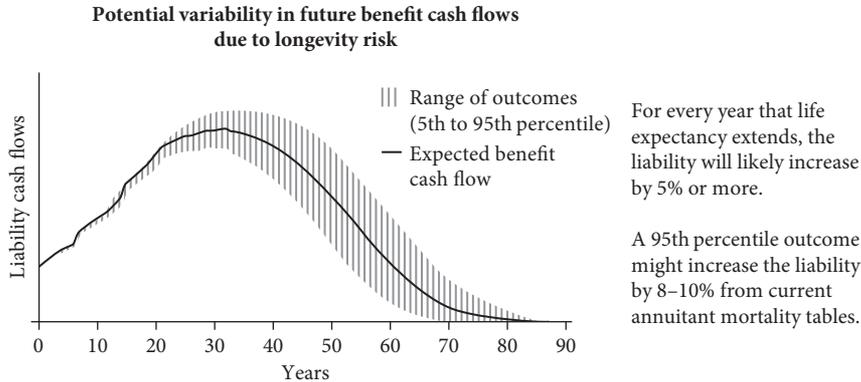
A recent Global Financial Stability Report by the International Monetary Fund (IMF 2012) explains that actuarial science has historically underestimated life expectancy by a period of three years. To be fair, the poor record around the accuracy of longevity projections has been driven by the incredible power of human ingenuity to develop medical treatments that extend human life and it is clear that increasing longevity is a very positive outcome for many. However, for sponsors of DB pension funds, increasing longevity also creates a significant financial obligation that governments, institutions, and corporations will struggle to afford.

The IMF report also points out that ‘appropriate longevity assumptions should use the most recent longevity data and allow for future increases in longevity’ (2012: 6). The same report suggests that ‘the use of outdated mortality tables has been a common practice’ among U.S. pension plans and that many in the IMF sample analysis exhibited a ‘lag of almost a quarter century in their mortality assumptions’ (2012: 13). A similar challenge exists in many countries, where measurement of current liabilities has not kept pace with known and observable improvements in longevity that have already occurred. The U.K. and the Netherlands are global role models in mandating the use of up-to-date tables, while progress remains slow in North America.

As the IMF has pointed out, updating pension mortality assumptions for purposes of estimating today’s liabilities is fundamental in creating the transparency that key stakeholders need in order to evaluate the impact of longevity risk on the credit quality of governmental, institutional, and corporate plan sponsors. Merely updating mortality assumptions is not enough, because there is still uncertainty around today’s best estimate projections of future pension liabilities. Pension funds must begin to consider how longevity risk interacts with all of their other risks and, in many cases, compounds them!

Figure 12.6 depicts the pure longevity risk in a pension fund with 36 percent retiree liabilities and 64 percent deferred and active liabilities, though no future

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**Figure 12.6.** Materiality of longevity risk assuming fixed inflation.

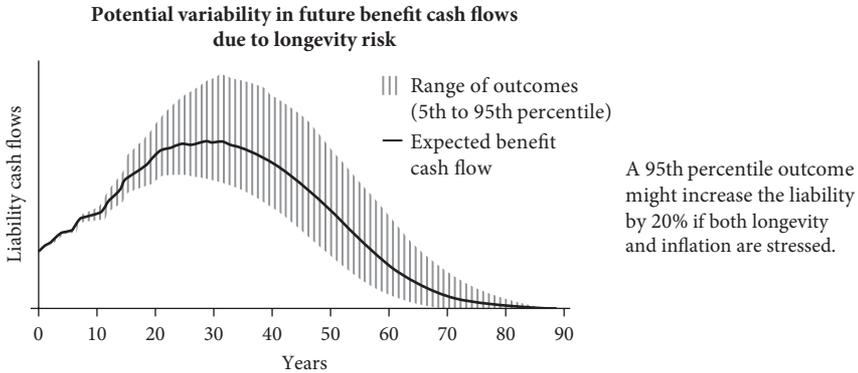
*Notes:* Shows the projected benefits and longevity risk for a pension fund with 36 percent retiree liabilities and 64 percent deferred and active liabilities, though no future accrual is assumed for active members. The average age of retired members is 69 and the average age of deferred and active members is 46. Benefits include cost of living adjustments, which are assumed at a fixed escalation rate of 3 percent. Longevity improvements are simulated in a fully stochastic analysis.

*Source:* Author's calculations.

accrual is assumed for active members. The average age of retired members is 69 and the average age of deferred and active members is 46. Benefits include cost of living adjustments, which are assumed at a fixed escalation rate of 3 percent in the graph. The solid line is the best estimate projection of the liability assuming the fixed cost of living adjustments and the grey bars indicate the risk around the best estimate determined on a stochastic basis where longevity is the only risk factor simulated in the stochastic analysis. For every year that life expectancy extends, the liability will likely increase by 5 percent or more. A more severe stress would increase the liability by 8 percent to 10 percent from current annuitant mortality tables but this analysis only stresses longevity.

Since this pension plan offers cost of living adjustments to plan participants, the risk of longevity and inflation combined is much larger. In the event that plan participants live longer than expected and inflation is higher than expected, the liability could increase by 20 percent because the longevity risk is compounded by inflation risk (see Figure 12.7).<sup>6</sup> The increase in risk is relevant for any U.S. public pension plan and any plan (public, institutional, or corporate) in the U.K., Canada, or elsewhere that offers a cost of living adjustment.

The fact that liability-side risks compound each other leads to an important conclusion about risk modeling and risk management. It suggests that hedging and risk transfer decisions must be made in the context of a fully stochastic analysis of all risks. Hedging and risk transfer decisions made without a combined stochastic model that brings liability risks into the picture will consistently undervalue the benefits of risk management strategies.



**Figure 12.7.** Compounding of longevity risk and inflation risk.

*Note:* Shows the same pension liability as depicted in Figure 12.6 with both longevity improvements and future inflation simulated in a fully stochastic analysis.

*Source:* Author’s calculations.

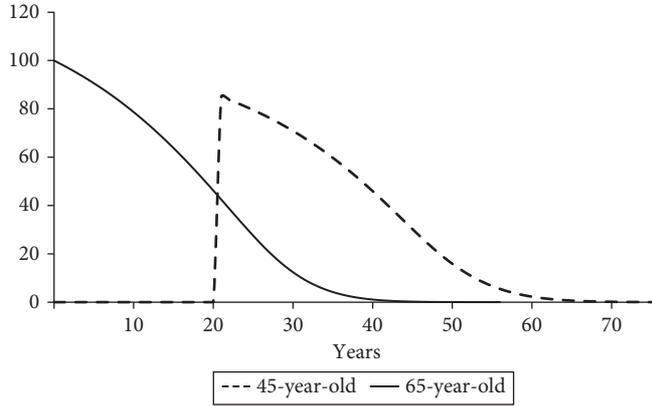
### Bringing Longevity Risk into the Picture

To demonstrate the importance of the compound nature of longevity risk, interest rate risk, and inflation risk, it is useful to consider a different example provided by Guy Coughlan of Pacific Global Advisors. In this example, there are 1,000 retired pension plan participants, all aged 65 and all receiving the same level of benefit today. There are also 1,000 active pension plan participants, all aged 45 and all expecting to receive the same benefit at their retirement in 20 years. The base mortality tables assume the U.S. male population, taken from the LifeMetrics Index. Inflation is expected to be 2.5 percent. In the fixed liability results, only salary inflation is assumed through the retirement date of the active pension plan participants with no benefit escalation after retirement. In the inflation-linked liability results, both salary inflation to the retirement date and escalation after the retirement date are assumed. The benefit payments are shown in Figure 12.8 for the fixed liability and the inflation-linked liability cases.

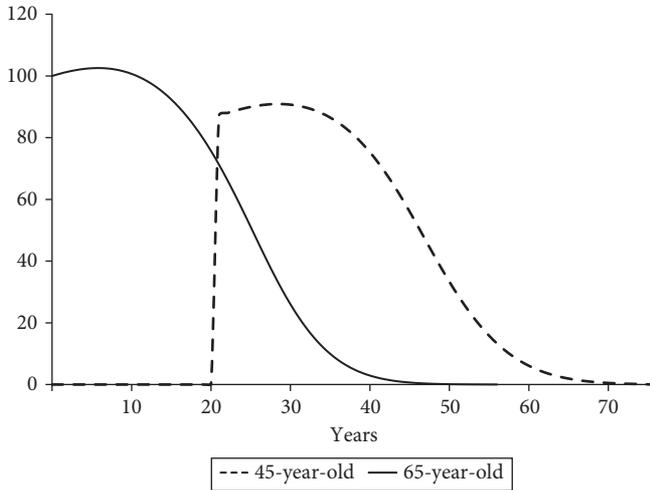
Thus the pension fund is not well funded and is holding assets of \$600, equal to only 60 percent of the liabilities, assumed to be \$1,000. Despite its underfunded position, the plan has already begun to make its way down a de-risking path and holds its assets invested in 45 percent fixed income, 33 percent equities, 19 percent alternatives and 3 percent cash. Figure 12.9 provides a risk overview for this plan. It shows the funded status-at-risk or value-at-risk (“VaR”) in the pension fund, reflecting the financial risk in the asset portfolio, as well as the market and longevity risks impacting the liabilities. For pension funds, funded status-at-risk is analogous to the VaR measures used by other types of financial institutions.

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Panel A. Fixed liability.



Panel B. Inflation-linked liability.



**Figure 12.8.** Illustration of fixed liability and inflation-linked liability cash flows (normalized pension payment).

*Notes:* Panel A: Fixed liability; Panel B: Inflation-linked liability. Depicts normalized pension payments for 1,000 retired and active plan participants aged 65 and 45, respectively, for fixed liabilities and inflation-linked liabilities.

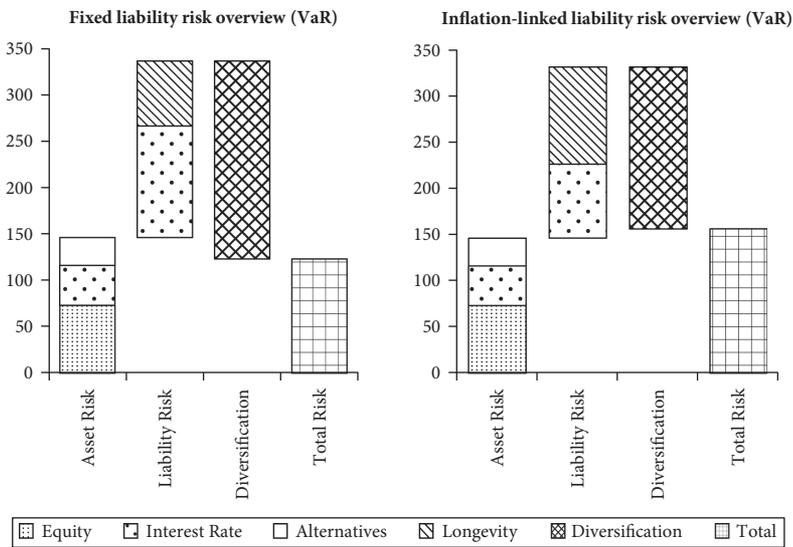
*Source:* Analysis from Pacific Global Advisors.

Funded status-at-risk measures the level of financial risk to the funded status of the pension fund, taking assets and liabilities into account. Figure 12.9 shows the amount of the potential loss in funded status at a 95th percentile stochastic stress

over a period of one year. The stress depicted below can be considered a reasonable worst-case scenario for a one-year period.

The individual asset and liability risks shown here depict the 95th percentile outcome of a stress in each risk in isolation. For example, asset risks (shown in the left-most column on each graph) include the risks to equities, interest rates, and alternatives and they reflect a 95th percentile risk of loss in each asset class stressed independently. The asset risks are the same in the two cases because each assumes a portfolio of \$600 invested identically. In normal market conditions, these losses would not be expected to occur simultaneously—rather, some of these losses will be diversified away, as described further on in the chapter.

The liability risks are shown in the second column of each graph in Figure 12.9. The liability risks differ in the fixed liability and inflation-linked liability cases. Relatively speaking, the inflation-linked liability has greater longevity exposure. This is intuitive, in light of the graphs shown in Figures 12.6 and 12.7, which demonstrate that the risk of longer life and high inflation compound each other. In other words, with inflation-linked benefits, a pension fund promises to make monthly benefit payments to its members that will keep pace with cost of living



**Figure 12.9.** Risk overview for fixed liability and inflation-linked liability cases (VaR). Analysis of a reasonable worst-case loss scenario for a one-year period for the hypothetical pension plan depicted in Figure 12.8.

Panel A. Fixed liability deterministic stress.  
 Panel B. Inflation-linked liability deterministic stress.

Source: Analysis from Pacific Global Advisors.

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adjustments. Should inflation be higher than expected, each additional year of life carries with it approximately twice the impact on the liability, because the benefit will be payable in future value terms. For years, we have described this exposure as ‘longevity risk on steroids.’

It is also of interest to note that the inflation-linked liability has less interest rate risk than the fixed liability. This is due to the fact that liabilities rise in low interest rate conditions, which are also commonly linked to low inflation environments. If inflation is low, the inflation-linked liability would benefit from lower-than-expected cost of living adjustments. This finding (in which inflation-linked liabilities are less interest rate-sensitive than nominal liabilities) is consistent with the fact that inflation-linked government bonds are less volatile in price terms than comparable nominal bonds.

The third bar in each graph in Figure 12.9 shows the diversification benefit that naturally arises because the risks detailed in the first two columns are not all expected to arise at their 95th percentile levels at the same time. Risks in the pension fund, whether on the asset or the liability side, are not perfectly correlated and they generally are not expected to occur together and *in extremis*. Consequently, the risks should diversify each other.

One of the best examples of a natural diversification benefit is longevity risk and equity risk, which are often thought to be unrelated risks—they may both occur *in extremis* by chance but the conventional wisdom is that there is no reason to expect them to both occur simultaneously *in extremis* and thus, the diversification benefit of holding the combination of risks is significant.

Another key source of diversification benefit is the relationship between interest rate risks on the asset and liability side. A 95th percentile outcome for interest rate risk on the asset side would generally occur when rates rise and fixed income assets fall in value. In contrast, a 95th percentile outcome for interest rate risk on the liability side would generally occur when rates fall, pulling down the discount rates used to value the liability and causing the present value of the liability to rise. These two circumstances are negatively correlated and offer a fairly direct hedge to the extent that the pension plan holds fixed income assets that are key rate duration-matched to the liability and are of similar credit quality to the liability measurement benchmark. The diversification benefit of the individual risks is substantial and can be thought of as reducing the pension fund’s funded status-at-risk by taking into consideration the fact that some of the risks are not correlated (such as longevity and equity risk), while others are negatively correlated (interest rate risk on liabilities vs. interest rate risk on assets).

The Total Risk column in Figure 12.9 is shown on the right of each graph. As a result of the diversification benefit, the Total Risk column is materially lower than the sum of the Asset Risk and Liability Risk columns, which depict the 95th percentile risk of funded status loss on each risk measured in isolation. For clarity, the Total Risk column shows the 95th percentile risk of funded status loss on the total combination of asset and liability risks, after taking the diversification benefit into account. As expected, the total risk results show that the inflation-linked

liability has more total risk and less diversification benefit than the fixed liability case. This is the natural conclusion because the actual liability growth rate of the inflation-linked liability (with cost of living adjustments) is more likely to outpace the earning power of the assets than in the fixed liability case, and this risk of growth in the liability outpacing the growth in the assets is unlikely to be diversified away by the assets this pension plan is holding.

### **A Simpler View of Crossover Risk**

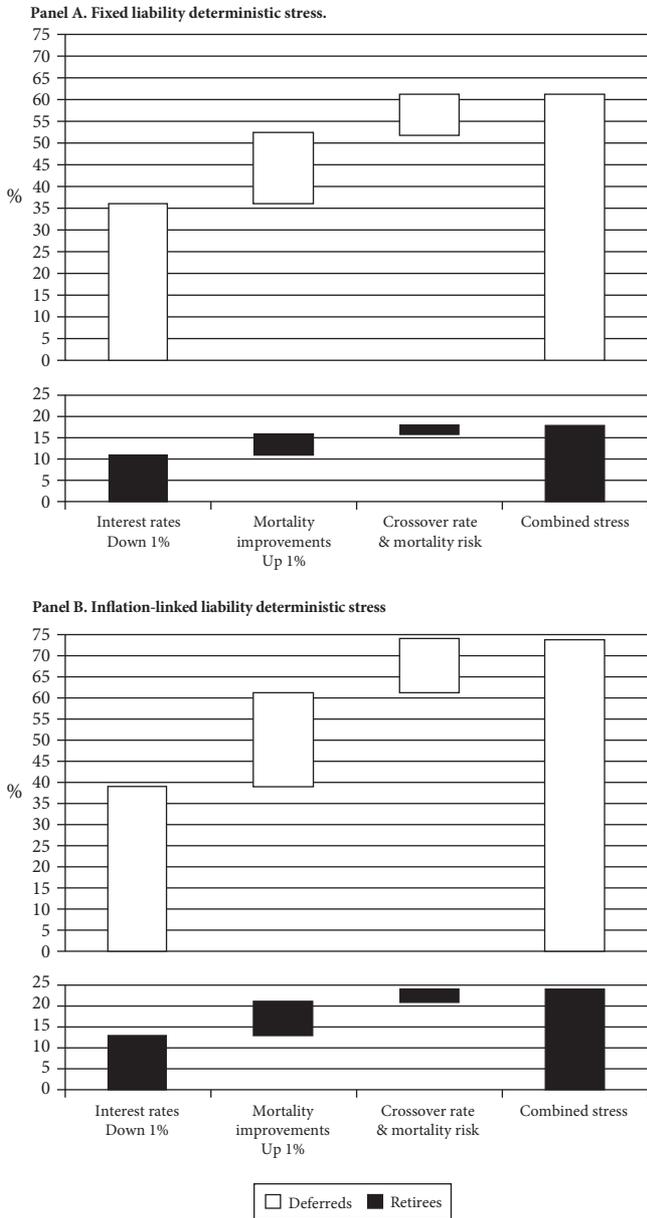
Many find the three-dimensional nature of stochastic VaR analysis challenging to interpret because the conclusions depend on the correlation matrix embedded in the statistical risk analysis, which drives the degree of diversification benefit among the risks. To address these concerns and provide a two-dimensional anchor for the risk analysis, it is also useful to look at deterministic stress alongside the stochastic analysis.

Coughlan's approach to the deterministic stress is to construct a stress that is reassuringly similar to a duration calculation.<sup>7</sup> For the fixed liability and the inflation-linked liability, Figure 12.10 shows the impact on the liability of a 1 percent decline in interest rates and a 1 percent per year increase in the future projected trend for mortality improvements (also referred to as '*q*-duration'). Results are shown separately for the older retiree population (the 65-year-olds) compared to the younger deferred members (the 45-year-olds) who have yet to retire. We conclude that longevity risk, interest rate risk, and inflation risk compound each other. In each case, the combined stress is greater than the sum of its parts (the interest rate stress and the mortality stress), because an interest rate shock will have a bigger impact on the liability if the liability increases due to an expectation of longer life. The difference between the value of the combined shock and the sum of the two individual shocks (interest rates and mortality) is referred to as the 'crossover rate and mortality risk,' and is broken out separately in Figure 12.10.

Both the combined stress and the crossover rate and mortality risk are bigger in the inflation-linked liability case than in the fixed liability case because inflation compounds both the mortality and interest rate risks. Also, both the combined stress and the crossover rate and mortality risk are bigger for the deferred liabilities (the 45-year-olds) than the retiree liabilities (the 65-year-olds) because of their longer duration. The analysis proves that deferred liabilities are the most risky obligations for the pension fund.

### **Implications of Crossover Risk for Risk Analysis and Risk Management**

Given the key conclusion that interest rate risk, longevity risk, and inflation risk compound one another in the pension liability, it is clear that the current standard



**Figure 12.10.** Deterministic stress on liabilities (impact of a 1 percent decline in rates and a 1 percent increase in mortality improvements). Panel A: Fixed liability deterministic stress. Panel B: Inflation-linked liability deterministic stress.

*Note:* Depicts the impact on the liability of a 1 percent decline in interest rates and a 1 percent per year increase in the future projected trend for mortality improvements.

*Source:* Analysis from Pacific Global Advisors.

practice of leaving longevity risk out of pension risk analysis will lead to an underestimation of total risk. This is particularly acute for inflation-linked liabilities and deferred liabilities, where their longer duration makes them significantly more sensitive to adverse outcomes. Pension funds and industry practitioners that make risk budgeting, risk management, and risk transfer decisions without taking these crossover risks into consideration will underestimate potential losses as well as the potential benefits from risk management and risk transfer strategies.

To this point, we have focused on pension asset and liability risk and on quantifying and understanding these risks in a manner that is more comprehensive than current general market practice. From this point forward, we focus on what these conclusions about risk actually suggest for risk management in the context of a DB Pension Sustainability Model.

### **The Role of Risk**

For most pension funds, the conventional strategy has relied upon asset risk-taking activities to minimize overall contributions to the pension plan. Toward that end, investment activities are often focused on endowment principles of retaining liquidity premiums, earning risk premiums, and maximizing diversification benefit. In carrying out this strategy, most pension funds have hoped to earn enough return to outrun increasing life expectancy and offer generous pension benefits with modest contributions. As shown in Figures 12.2 through 12.4 of this chapter, the key issues associated with this strategy include: (a) the lack of focus on the liability and its risks; (b) the volatility; and (c) the risk of loss that cannot be overcome in the medium term.

The challenge for the pension industry today is to modify the conventional endowment strategy to moderate the role of risk. Figures 12.2 through 12.5 provide the historical data that demonstrate the need for a change in general pension risk management practices. In the new paradigm, the role of risk must be more carefully harnessed than has been the case in the past. Potential losses must be budgeted so their impact on required pension contributions in the medium term is affordable for the plan sponsor. Within the overall risk budget, pension plans should still retain liquidity premiums, earn risk premiums, maximize diversification benefit, and seek to minimize overall contributions.

The key change is that all of these activities would be limited and controlled within the risk budget and, within that risk budget, risk-taking would still have an important role to play in pension risk management.

### **Managing Total Risk and Risk Budgeting**

In managing the total risk exposure of a pension fund, we have said that it is important to ensure that the potential losses are budgeted so that their impact on required pension contributions in the medium term is affordable for the plan

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sponsor. We expect very few to disagree with this goal because losses that are not affordable can impair the sponsor's credit quality or render the sponsor insolvent, leaving the plan without adequate resources to pay benefits to plan participants. To bring our broadly stated objective forward into risk practice, it is important to be specific and define each element.

*Potential losses* refer to funded status-at-risk or total risk as shown in the right-most bar in each of the graphs in Figure 12.9. This is the potential loss in funded status in a reasonable worst-case (95th percentile) scenario that takes into consideration asset risks, liability risks, and diversification benefits. We are focused on funded status-at-risk because this is the amount the plan sponsor would need to contribute in cash to overcome these potential losses.

*Budgeting the impact on required pension contributions* refers to managing the pension fund's asset and liability risks to try to keep potential losses below a specific funded status-at-risk or total risk level. Again, the plan sponsor may have to make contributions of cash to overcome these potential losses, and it is the potential cash contributions that need to be budgeted and affordable in order to ensure sustainability.

*Medium term* refers to the plan sponsor's reasonable time horizon for recovery from a market disruption. In some circumstances, the reasonable time horizon will be driven by regulation in the home country or province of the plan sponsor. For example, U.K. corporate pension funds are generally required to make cash contributions to recover from pension deficits within three to five years. U.S. corporate pension funds will increasingly focus on a seven-year horizon in light of the guidelines in the Pension Protection Act (PPA). Plan sponsors in Ontario also have a prescribed period over which they must recover. These regulatory recovery periods can help plan sponsors define the 'medium term' because cash contributions may be required over this period to restore the pension fund to good health. In instances where there is no regulatory requirement for recovery, as is the case for U.S. public sector pension funds, it will be more challenging, though no less important, to establish a disciplined construct for budgeting potential losses.

*Affordable for the plan sponsor* will have a different meaning for every sponsor. In tailoring the definition of 'affordability' to each unique obligor, we recognize that public pension plans will need to control the impact of potential losses to ensure the loss is affordable in terms of the sponsor's debt burden or future tax burden. In contrast, corporate plan sponsors will need to control the impact of potential losses to ensure the loss is affordable in terms of their debt burden, considered alongside such other factors as shareholders' equity and free cash flow. Today, the vast majority of pension plan sponsors fail to manage the funded status-at-risk so that it is affordable in the context of debt burden, future tax burden, shareholders' equity or free cash flow, but this is the key step in risk budgeting. It is worth considering each of these key metrics in turn.

*Debt burden.* Today, credit analysts are increasingly aware of the nature of unfunded pension liabilities, which are the debt of the plan sponsor and which

may come ahead of any other debt or equity. Losses in the pension fund increase the sponsor's debt and, as such, growing pension deficits are increasingly a factor in rating downgrades and credit analyst commentary. A corporate, institutional, or municipal plan sponsor must determine whether losses in an amount equal to the funded status-at-risk would have a detrimental impact on its debt burden if the potential losses were realized. Given the nature of unfunded pension liabilities, key stakeholders consider: (a) whether potential losses would cause a debt rating downgrade or result in negative credit analyst reviews if realized; (b) whether any debt covenants would be violated; and (c) whether market access or other credit objectives (such as target debt ratios) of the sponsor would be threatened.

*Impact on tax burden.* This metric is relevant only to public plan sponsors whose pension plan contributions are funded by tax revenues or user fees. Losses in the pension fund may increase the sponsor's required contributions and create pressure on tax revenues or, where tax revenues cannot be raised, the pension contributions may displace needed public services. A public plan sponsor must consider whether losses in an amount equal to the funded status-at-risk would have a detrimental impact on its tax burden if the potential losses were realized and the requisite contributions were made to restore the pension fund to good health. Key stakeholders consider: (a) whether the potential losses and resulting contributions would cause tax rates to rise substantially; (b) whether there are legal, constitutional, or practical limits on the potential tax increases that might be violated; (c) whether tax revenues would need to be diverted from public services to make the contributions; (d) the probability that the municipal entity would be downgraded; (e) whether market access or other credit objectives of the sponsor would be threatened; and (f) whether residents and businesses would choose to locate in other municipalities to avoid the increasing burden of pension risk.

*Impact on shareholders' equity.* For corporate plan sponsors, losses in the pension fund that increase the company's debt burden also reduce its shareholders' equity because the increase in net effective debt does not create any investment in the enterprise nor any earning power for the firm. Current accounting rules appropriately capture this reality in the balance sheet mark-to-market approach that prevails today for corporate pension assets and liabilities in the U.S., U.K., and Canada, among other countries. Given the importance of shareholders' equity to investors, many companies are now considering whether the funded status-at-risk would have a detrimental impact on shareholders' equity if the potential losses were realized. It is particularly important to do this analysis for the plan sponsor alongside all of the other companies in the plan sponsor's industry peer group to determine the extent to which the plan sponsor would underperform its peers in a down market. Cyclical companies must also be very focused on these calculations because cyclical companies are likely to see declining equity values in the same market conditions that are challenging for the pension fund.

*Impact on free cash flow.* To the extent that pension losses trigger a requirement to contribute cash to the pension fund, a corporation's free cash flow can be severely

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impacted by pension risk. Moreover, free cash flow is at the foundation of shareholder value creation, which has led to the reasonable conclusion that ‘cash is king.’ Toward that end, we see companies with limited free cash flow taking the lead in pension de-risking to minimize potential cash calls on the company and ensure more consistent financial results within their industry peer groups. There was a raging debate in the United States before the recent financial crisis as to whether it was in the best interest of plan participants to moderate or budget the risk taken in the pension plan to ensure that potential losses would be affordable from the perspective of the plan sponsor. However, by the end of 2012, the Pension Benefit Guaranty Corporation in the United States was responsible for benefits to members of over 25,000 U.S. pension funds whose sponsors had previously filed for bankruptcy (PBG 2013). As a result of these insolvencies, the benefits payable to many of the plan participants were capped below their original levels and the plan participants experienced the double challenge of a simultaneous decline in their retirement security and their job security. If potential pension losses are unaffordable for the plan sponsor, plan participants may face this difficult situation.

### **Allocating the Risk Budget: Choosing Your Risks**

Once a plan sponsor defines its risk budget, the focus often turns to trimming overall risk to bring funded status-at-risk down to the targeted level. In this exercise, pension plans most often begin with a risk assessment such as the one shown in Figure 12.9 of this chapter. The risk assessment helps to quantify the risks the pension fund is running in order to begin an analysis of which risks to keep, which risks to manage, and which risks to shed.

From the point of the initial risk assessment, there are three key considerations in determining a risk reduction strategy. First, the risk assessment clearly identifies the largest sources of risk, where the greatest impact of risk management can be achieved but charting a successful course to a lower risk future is never as simple as attacking the largest risks and trimming them back. Second, it is critically important to consider which risks the plan believes are rewarded risks and which are unrewarded in order to prioritize rewarded risk-taking within the risk budget. Finally, the balance of risks is the key to an optimal outcome so that the plan makes the most of the diversification benefit available in its portfolio of risks.

In the risk reduction journey, we have seen several leading plans establish the following core principles. First, before risk reduction, interest rate risk, inflation risk, and longevity risk create a substantial amount of risk for the plan, but: (a) these risks compound each other; (b) each carries with it a lower expectation of returns than equity risk and investments in alternatives; and (c) within the overall risk budget, prioritizing rewarded over unrewarded risks is fundamental. Second, in reducing the overall level of risk, interest rate risk, inflation risk, and longevity risk

should be trimmed ahead of equity risk and investments in alternatives. Third, to make the most of the diversification benefit among the risks, no risk should be completely eliminated. Fourth, the liabilities matter, so younger plans with a lot of deferred and active participants will take more risk than mature plans that are primarily composed of retirees.

The following section describes two real pension plans—one corporate and one public—that have applied these principles to successfully reduce their pension risk.

### **Case Study: A Closed Corporate Plan in a Cyclical Industry**

Several closed corporate plans in the United Kingdom have dramatically reduced risk by applying the principles described above. They typically began with the realization that longevity risk, interest rate risk, and inflation risk are ‘unrewarded’ risks that need to be balanced and managed carefully within a risk budget.

One such plan (depicted in Figure 12.11) was extremely good at fixed income asset management; it brought its portfolio allocation up to 70 percent to 75 percent fixed income, including illiquid fixed income (such as private placement loans, commercial mortgages, inflation-linked ground leases, and high-quality credit card and auto loan ABS). The fixed income portfolio was built over many years and in many interest rate environments and allowed the plan to address its interest rate risk very effectively. Inflation risk was hedged or managed through investments. The remaining 25 percent to 30 percent of the portfolio was in equities, absolute return, and other alternatives, meaning that the plan could benefit from the diversification of risk among its various asset classes.

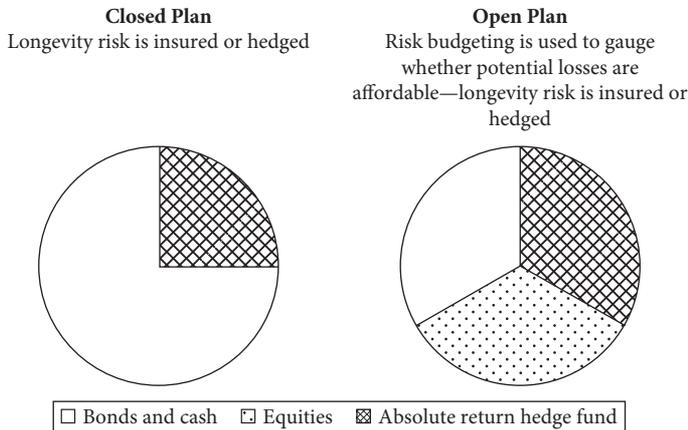
By the time the pension plan was invested in 70 to 75 percent fixed income, its downside risk was very well managed, but its upside earnings potential was greatly diminished too. The plan no longer had enough potential in its portfolio to earn its way out of an unexpected increase in life expectancy. The solution chosen by this plan was to run its asset portfolio alongside a longevity insurance transaction providing both asset and liability risk management. This strategy works for any large, sophisticated plan sponsor, though cyclical companies have the biggest incentive to reduce risk because the biggest pension losses arrive in downturns when equities and interest rates are falling simultaneously. These are the same moments when the business would need to conserve cash to manage through the business cycle. For this cyclical company, having a properly risk-managed pension plan (with a funded status-at-risk below its risk budget) meant that it could solidify its industry leadership, create more consistent financial results, and manage from a position of strength in down markets. Eliminating this fundamental risk to the company also enhanced the retirement security and the job security of the plan participants.

**Case Study: An Open Public Plan**

The risk budgeting and risk management strategy described above is not only for corporate plans. Public pension plans can pursue these strategies as well even though many public plans are still open and actively accruing benefit for plan participants. In these circumstances, the plan is likely to insure its longevity risk and target a higher asset risk level than a closed, mature plan, as shown on the right side of Figure 12.11. One public plan that pursued this strategy combines longevity insurance with a diversified asset portfolio that is one-third bonds and cash, one-third equities, and one-third absolute return. Its strategy is based upon risk budgeting and the strong belief that longevity risk is unrewarded, particularly when combined with (and compounded by) interest rate risk and inflation risk. The plan’s CIO saw the exposure to longevity risk as a bond that routinely lost 2 percent or more each year. To put a floor on those losses, the plan decided to hedge away the longevity risk on the retirees and turn the liability into a known and knowable future obligation. The risk budget previously taken up by longevity exposure could then be re-allocated to rewarded risk-taking in the asset portfolio.

This is a revolutionary concept, made possible by longevity insurance. Pension funds can now choose to hedge longevity risk as an unrewarded risk and redeploy that risk allocation to rewarded risk-taking in the asset portfolio.

Many have asked what plan participants might gain from this risk management approach. The answer is likely retirement security. In an open plan for a public entity that is still accruing benefits for current employees, there is a fundamental



**Figure 12.11.** Sustainability model.

*Note:* Summarizes a sustainable asset and liability strategy for a closed plan and an open plan, respectively.

*Source:* Author’s illustration.

question of whether the plan is adequately reserved for the longevity risk of current retirees and, if it is not, what impact that will have on current employees contributing to the plan. Managing asset risk and hedging the longevity risk of the retirees in the plan can address the intergenerational risk current employees face in circumstances where pension deficits are acute, the credit quality of the plan sponsor is weak, and life expectancy is underestimated. This is the essence of the DB Pension Sustainability Model as it brings into practice techniques for managing investment risk, longevity risk, and intergenerational risk in today’s open pension plans.

**Lessons Learned from Monoline Pension Insurers**

There are many differences between most pension funds and the world’s best-run pension insurers, but first we will focus on the similarities. Both are monolines that have written pension annuities and therefore grapple with asset risk and longevity risk. The similarities generally end there, because monoline pension insurers manage their blocks of business under insurance principles, while the pension funds, with the same annuity liabilities, remain focused on the endowment principles of retaining liquidity premiums, earning risk premiums, and maximizing diversification benefit to minimize overall contributions. The key differences are presented in Table 12.1.

The key to bringing the DB Pension Sustainability Model into practice is not to bring pension funds to manage risk fully under the insurance principles applied to the monoline pension insurers. Rather (in order to address the risks shown in Figures 12.2 through 12.5 of this chapter), the focus is on finding the happy medium between the two models for pension funds that seek to sustain themselves for the long run. The goal is to be able to keep the pension promises they have made and provide retirement security for plan participants even in the face of shifting demographics and increasing longevity. The halfway point between the insurance model and the conventional pension model is a moderate approach with plans: (a) managing just below fully funded status without any reserves or capital behind the risk; (b) maintaining a low volatility asset strategy that is heavy in fixed income and absolute return with a modest allocation to risky assets to

TABLE 12.1 Comparison of pension funds and monoline pension insurers

	Pension Funds	Monoline Pension Insurers
Funded level	Generally underfunded	Fully funded plus reserves & capital
Asset strategy	High allocation to risky assets	Asset and liability matching
Longevity risk strategy	Generally unhedged	Generally reinsured
Risk budgeting	Generally not applicable	Potential losses < capital and reserves

Source: Author’s tabulation.

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benefit from diversification of asset classes; and (c) hedging the longevity risk of their retirees to ensure sustainability even in the face of longer life.

This moderate approach is designed to benefit from much of the stability of the insurance model, without the extra capital and reserves it requires. At the same time, the moderate approach continues to take advantage of some of the diversification benefit among asset classes that is the hallmark of the conventional pension approach. By combining the two models, it is possible to help pension funds develop an approach to moderate risk and bring potential losses into an affordable range.

### **Conclusion**

People are living longer lives but the normal retirement age in most countries has been the same for decades. As a result, there is a demographic shift observable within many pension plans: the number of retired persons to be supported by the plan is rising much faster than the number of working age people contributing to the plan. This intergenerational risk creates an acute need for open pension plans to move retirement age later with increases in healthy life expectancy.

While this demographic shift continues unabated, a low-growth/low interest rate environment is creating a substantial funding gap for plan sponsors. Maintaining a high risk profile to bridge the gap may result in investment losses as unaffordable as they have proven to be in the first decades of the twenty-first century.

Today's path for pensions is unsustainable. This chapter develops a way to budget and moderate risk, provide for increasing longevity, manage the intergenerational risk in the pension plan, and create greater certainty that participant benefits can be met. The retirement security of many pension plan participants depends upon it.

### **Acknowledgements**

The author thanks Guy Coughlan for providing the analysis for Figures 12.8 through 12.10 and for being a willing collaborator to so many in our industry. She also appreciates excellent comments from Gary Knapp, Peter Patrician, Jo Alvarez, and Daniel Bertram. Finally, she thanks the many pension funds with whom she works for sharing their concerns about risk and their aspirations for a better future.

### **Notes**

1. This reflects the history of the ten-year U.S. Treasury, taken from the Daily Treasury Yield Curve, which was at its highest level in nearly six years on June 12, 2007, at 5.26 percent and has generally fallen for the five ensuing years, to 1.43 percent on July 25, 2012.

2. The ten-year Treasury rate data collected by Shiller (2013) show rates below 3 percent for 19 years from 1934 to 1953.
3. Interest rate data are for ten-year U.S. Treasuries, taken from the Daily Treasury Yield Curve (U.S. Treasury 2013), which was at 3.22 percent on July 1, 2011, and 2.07 percent on August 19, 2011. Equity data reflect the S&P 500 Index, which closed at 1339.67 on July 1, 2011, and 1123.53 on August 19, 2011 (Bloomberg 2013).
4. Cumulative assets (in US\$billions) and liabilities of all pension schemes in the S&P 500 index on the accounting basis.
5. This assumes a pension fund with 36 percent retiree liabilities and 64 percent deferred and active liabilities, though no future accrual is assumed for active members. The average age of retired members is 69 and the average age of deferred and active members is 46. Benefits include cost of living adjustments, which are simulated in a fully stochastic analysis. Longevity improvements are also simulated in a fully stochastic analysis.
6. This assumes a pension fund with 36 percent retiree liabilities and 64 percent deferred and active liabilities, though no future accrual is assumed for active members. The average age of retired members is 69 and the average age of deferred and active members is 46. Benefits include cost of living adjustments, which are simulated in a fully stochastic analysis. Longevity improvements are also simulated in a fully stochastic analysis.
7. See also Coughlan (2014).

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