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**U.S. Corporate DB Pension
Plans—*Today's Challenges***

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This article analyzes the multiple considerations facing a corporate sponsor making decisions about its defined benefit (DB) pension plan. First, we examine why so many plans have closed and/or shifted to more conservative asset/liability allocations. Second, we discuss the challenging balancing act for underfunded plans when making their asset class allocation, duration-matching, and contribution choices, as well as the risks and costs associated with each choice.

DB plans provide major advantages to beneficiaries and a competitive edge to their providers, as they take investment risks and longevity risks off the shoulders of beneficiaries. However, for a variety of reasons, many pension sponsors have in recent decades shifted—at least partially—from DB plans to defined contribution (DC) plans. The rising size of pension obligations, challenging market developments, and accounting and regulatory changes have combined to make a DB plan's funding status more volatile and more problematic for many U.S. corporations. Another result of these developments is that sponsors that 15 or 20 years ago preferred equity-oriented asset portfolios, so as to minimize expected pension contributions, have shifted toward more bond-oriented portfolios, so as to reduce funding ratio (FR) volatility and contribution uncertainty.

Recalling the old Chinese curse, corporate pension sponsors have lived in interesting times. In 2007, the average FR among U.S. corporate DB plans was 105%, but with the toxic combination of the 2008 market debacle and a precipitous decline in discounting rates, the FR plunged to around 80%. Worse yet, with adverse changes in mortality tables and further discount rate declines, the FR has stubbornly remained at this 80% level in spite of the historically high post-2008 asset returns.¹ The challenge for sponsors is to find the most economical strategy for moving the FR from the current deficit level to back above par, whether they intend to keep the plan open or close it.

This liability-driven Investment (LDI) endgame requires careful cost-benefit analysis. Projected obligations are uncertain, exact liability matching is expensive (and may get more expensive given the scarcity of LDI assets), and closing the plan will require a reported FR well over 100%. Some sponsors may choose to limit the risk of a pension plan by hedging its main equity and duration risks and then keep the plan on the balance sheet, while others will pay up for removing all pension obligations from their balance sheets.

Underfunding can be closed by favorable market moves or by sponsor contributions. Two main ways sponsors hope to “let the market do the work” are equity overweights

and bond/duration underweights.² Sponsors who believe in equities' long-run outperformance favor retaining the equity overweights, while others may seek to reduce equity downside risks while retaining the return potential by using more diversifying alternative solutions. Sponsors who expect bond yields to rise from their multi-decade lows favor retaining the bond and/or duration underweights. (Some firms may consider issuing long-term debt at low yields to cover the underfunding, but this would require taking a broader view of the corporate balance sheet.)

Sponsors can make distinct “de-risk or not” decisions on these two issues. Not de-risking raises the possibility of having to de-risk at even worse FR levels. De-risking at a deficit level may lead to a situation where contributions must rise to make up the deficit.

At this point, the typical plan may have a significant—but incomplete—duration hedge in place and a lower percentage allocation to non-bond assets. Going forward, a number of funds have adopted a relatively formal “glide path”—a pre-commitment framework for progressive de-risking as FRs improve (and possibly as interest rates reach more palatable levels). But even without such formalization, other sponsors may move toward higher duration-based hedge ratios through a sequence of one-off decisions in response to changing market conditions.

In a typical glide path strategy, the bond weight and/or bond duration in the asset portfolio would be gradually increased while the weight of equities and other risky assets would be reduced. Once the duration-based hedge ratio is close to one, and the earnings power of the remaining non-bond component is modest, even rising bond yields or favorable risky asset moves would not boost the FR by much. If such a “stall” situation occurs when the FR is below 100%, the underfunding would have to be covered only by sponsor contributions.

HOW DID WE GET HERE?

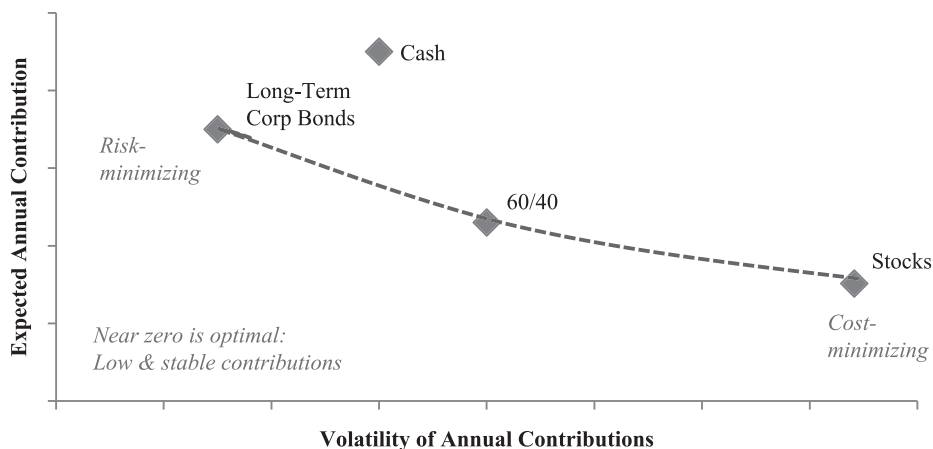
We begin by providing historical perspective before turning to best practices in today's challenging environment. Many U.S. corporate pensions have been shifting from DB plans to DC plans in recent decades. The pros and cons of DB versus DC plans have been widely discussed (see Appendixes A and B). Another (more recent) shift involves DB plans moving from equity-oriented

portfolios to liability-driven investing and larger bond holdings.³ Both changes reflect the increasing reluctance of plan sponsors to underwrite the risk of rising pension contributions. To better illustrate the change in approach over time, we contrast the mindset of a corporate DB plan sponsor in the 1990s to that in the 2010s and delve deeper into some environmental changes.⁴

In the 1990s, plan sponsors knew that, from an asset-only perspective, there is a long-run return advantage of equities over fixed income, while the asset-liability surplus perspective emphasized the role of long-duration bonds as the best liability hedges. However, the sponsors' primary concern may have been pension contributions. The value of plan assets reflects the sum of sponsor contributions and the investment returns earned on them, so it is not surprising that many firms preferred to “let the equity market do the work” and hope to realize the long-run equity premium to reduce the needed contributions. Indeed, during the 1990s equity bull market, many plans with large equity allocations enjoyed several years of “contribution holidays” and still saw their funding levels, which were in many cases already high, rise further. As Exhibit 1 shows, while this approach potentially reduced expected pension contributions, it made future contributions less predictable (given greater reliance on a more volatile asset class). Accepting the resulting volatility in contributions and/or funded status seemed a compelling risk/reward trade-off, especially when any plan deficits appeared small and manageable and recent equity market history suggested (to some) that markets could rise strongly for a long time to come. The risk part became obvious only after adverse capital market moves in the 2000s caused contribution requirements to rise sharply.

High equity allocations (60% or even higher) in pension assets were also supported by the actuarial approach in the 1990s of discounting liabilities by the assumed expected return on the fund's assets. (This practice was motivated by pension plans' presumed long investment horizon and ability to look beyond market fluctuations.) Prevailing legislation gave sponsors flexibility when determining regular pension contributions. Actuarial projections effectively treated asset returns as if they were certain, allowing plans to fund future liabilities with a smaller amount of today's dollars. (Because the larger allocation to risky assets and the higher assumed future return on those assets produced higher discount

EXHIBIT 1 Stylized Risk/Reward Trade-Off in Pension Contributions



Note: For illustrative purposes only.

rates, smaller contributions were required according to relevant laws and regulations.)

Pension sponsors also had flexibility in pension accounting. New accounting rules in the late 1980s (FASB 87) moved corporate DB plans from pay-as-you-go to a funded approach. In principle, the funded approach involved discounting liabilities at corporate bond yields, but some accounting items (unrecognized pension gains/losses and prior service costs) gave sponsors leeway from market-based valuations, so that the assumed expected return on assets could still anchor pension accounting.

Finally, as long as plans were open and projected pension obligations were expected to grow with wages, equities were seen as potential hedges for this part of the liability (not perfect hedges but still better than nominal bonds).

TRANSITION IN 2000s

Many sponsors were content with their pension plans at the turn of the millennium, thanks to strong equity market returns that resulted in large overfunding. Most DB plans had a risky position—overweight equities and underweight fixed income—that worked well in the 1990s but hurt in the 2000s. The shock was painful when markets turned and so many old assumptions turned out to be overly optimistic: No more talk of pension plans as a profit center.

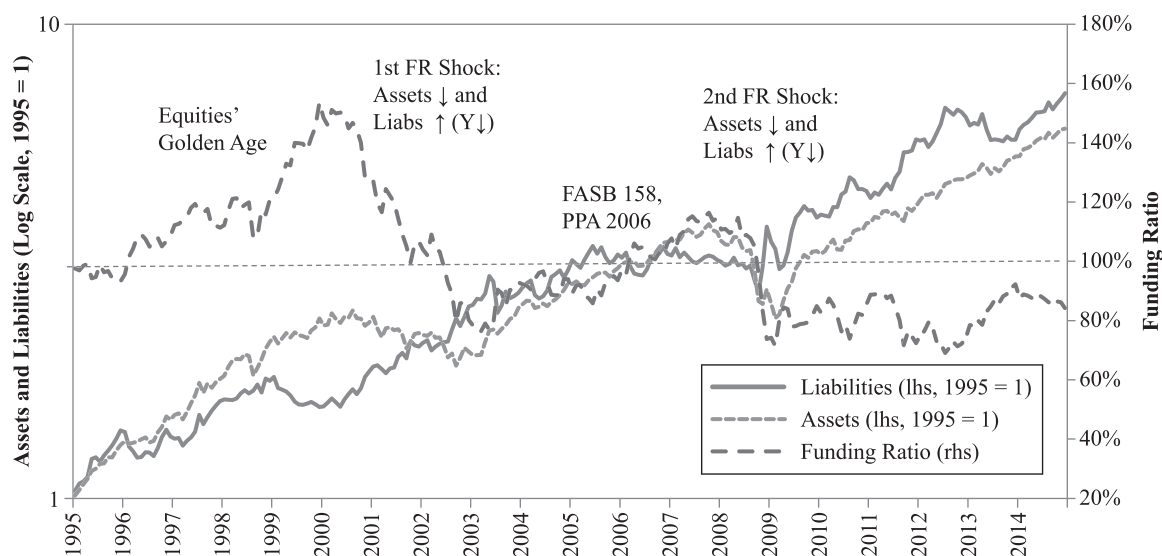
The aggregate annual pension contribution paid by the Milliman Top 100 corporate DB plans grew from about \$10 billion in 2000–2001 to the \$30 billion–\$60 billion range in each year since then, and even these large contributions did not prevent underfunding.⁵ The FR of the Milliman Top 100 collapsed from 123% in 2000 to 82% in 2002, thanks to a perfect storm of plunging equity markets and bond yields. Even though some recovery followed, the FR saw another sharp drop in 2008 (from 105% to 79% in one year) and has stayed below 100 ever since. Exhibit 2 shows the growth of proxies of pension assets and liabilities as well as the FR between 1995 and 2014.⁶

The 2000–2002 experience made many plan sponsors appreciate for the first time that they had a meaningful amount of risk in their pension plans, sometimes more risk than in their operating businesses. The FR plunge was mainly driven by market moves, but there were more gradual forces in play as well; increasing longevity also boosted the pension obligation.

The next headwinds came in the mid-2000s with changes in accounting and regulatory rules. The rules governing pension plan accounting and pension plan regulatory contributions are quite distinct, implying different discount rates and thus different FRs. However, in 2006, the Financial Accounting Standards Board statement 158 (FASB 158) and the Pension Protection Act (PPA) both moved to tie the liability discount rate for single-employer pension plans more closely to the market-based corporate bond yield.

EXHIBIT 2

Cumulative Growth of Proxies for DB Plan Assets and Liabilities as Well as Their (Funding) Ratios, 1995–2014



Sources: AQR, Citigroup, Ehrhardt et al. [2015].

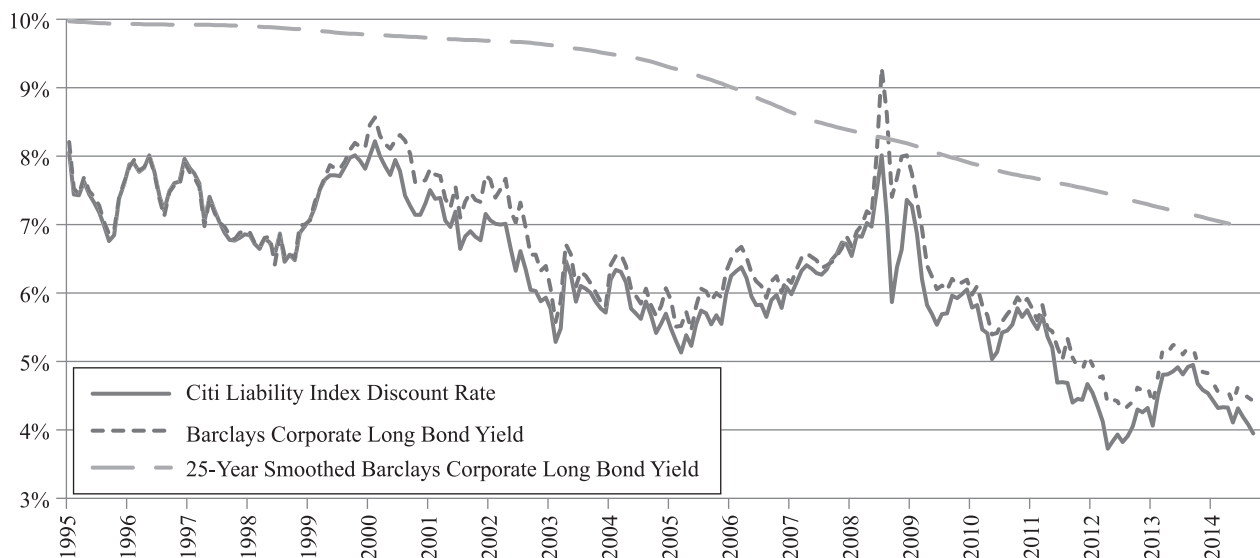
- **Balance sheet volatility:** FASB 158 changed the way in which plan sponsors account for pension plans on their balance sheets. The discount rate used to measure pension obligations for a single-employer's corporate plans for financial (GAAP) accounting purposes became tied to corporate bond yields, with no smoothing allowed (unlike in required contributions, discussed later), bringing FR fluctuations directly to the balance sheet.⁷ Compounded by the larger size of pension plans and volatile market moves, this change has caused significant balance sheet volatility after 2006 for plans that had not de-risked, and financial markets are paying attention. Maybe worse, earnings volatility also increased as the discount rate fluctuations raised pension expenses just at the time when operating earnings were depressed.
- **Contributions:** When calculating funding contributions for pension plans, PPA 2006 mandated the use of a specific set of interest rates based on high-quality corporate bond yields published by the Department of the Treasury. The new law stressed that when determining the required minimum contributions for any underfunding, FRs would be based on corporate bond yields instead of

assumed expected asset returns. Nevertheless, PPA allowed some *smoothing* (using the past 24 months' average yield) and allowed contributions needed to close underfunding to be made *gradually* (over a seven-year period; this still implied tightening contribution practices because previous regulations had allowed more flexibility). Since corporate bond yields were lower than the expected asset returns, and there was little appetite for sharply higher contributions, a five-year *phasing-in period* was included in PPA. As the period of low bond yields persisted beyond this period (and actually got worse after the 2008 Treasury yield fall and the 2009 corporate-spread narrowing), further *temporary* relief to the sponsor came in MAP-21 2012 and HATFA 2014 legislations through much more aggressive smoothing. Plans were able to base discount rates on 25-year average corporate bond yields, thus keeping the regulatory discount rates well above market yields. Note that going back 25 years includes the early 1990s, when corporate bond yields often approached 10%.⁸

Exhibit 3 shows the discount rate of the Citi Pension Liability Index and the yield of the Barclays

EXHIBIT 3

Citi Liability Index Discount Rate and Barclays Corporate Long Bond Yield without and with Smoothing, 1995–2014



Sources: AQR, Barclays, Citigroup.

Corporate Long Bond Index. (The Citi index has lower yields because its AA rated bonds have better credit quality than the Barclays index investment-grade bond composite.) We display the latter because we can also track a history of a smoothed 25-year average version. The smoothed version remains high today (near 7%) but has fallen sharply in recent years both because corporate yields have fallen since 2008 and because the double-digit yields of the 1980s have gradually dropped out of the 25-year window. The unsmoothed discount rate has halved during the past 20 years; this trend, together with the prevalent duration mismatch (asset duration is often about half of the liability duration), is the main reason for the net decline in FRs over this period.

Two other developments are partially offsetting the relief from MAP-21/HATFA, and these are not temporary but imply sustained increases in pension obligations.

- **Pension insurance costs:** PPA also influenced Pension Benefit Guaranty Corporation (PBGC) insurance premiums and tied them to corporate bond yields. Plan sponsors must pay a flat-rate premium per participant and a variable premium that increases with the level of underfunding.⁹ Recent legislation has raised the variable premiums significantly for

2014, 2015, and onwards, increasing the economic cost of liabilities and, in particular, plan deficits.

- **Longevity:** Workers' longer lifespans boost sponsors' pension obligations. While actual longevity improvements are gradual, actuaries "catch up" and modify their mortality assumptions more discretely. The latest adjustment to the Society of Actuaries' mortality tables occurred in October 2014 and is expected over time to increase most DB plans' projected benefit obligation (PBO) by 4%–8% and reduce their FR by a comparable amount.

The variety of discount rates used in different contexts makes it hard for non-experts to follow discussions on pension plan FRs.¹⁰ For clarity, we describe the recent FR evolution of the Milliman index of Top 100 corporate DB plans—and then describe how other FR measures might differ. The FR of the Milliman index was at a record-low 77.1% at the end of 2012 amid very low bond yields. The FR improved by 10% to 87.7% during 2013 thanks to healthy equity markets and a rising discount rate (from 4.03% to 4.75%). Then 2014 saw a retracement, as the FR fell to 81.7% (both assets and liabilities grew at double-digit pace, the latter even faster as the discount rate fell from 4.75% to 4.00%).

This FR figure includes at least partially the impact of the adjusted mortality tables.

The Milliman index uses pension accounting (GAAP basis), and thus discounts liabilities at the corporate bond yields prevailing at the year-end (with no smoothing). The discount rate used for calculating the degree of underfunding that determines the PBGC variable insurance premium is the original PPA specification with 24-month smoothing (PPA basis), so it is mildly different. The discount rate used for calculating pension contributions, which allows 25-year smoothing (PPA/MAP-21 basis), is significantly higher, implying about 10% higher FRs than the other discount rates.¹¹

All of these developments help explain why, in the 2010s, plan sponsors are much less willing to accept the risk/reward trade-off between more volatile contributions and lower contributions than they were in the 1990s. Various macro forces contributed to the shift from DB plans to DC plans (see Appendix B); once plans were closed to new employees, the case for equity investing became weaker and the case for de-risking became stronger. Dramatic market moves in the 2000s made plan sponsors more aware of the risks they held in terms of FR volatility as well as more onerous and more uncertain future contributions. Accounting and regulatory changes made FR fluctuations more visible in the balance sheet and made it harder to smooth contribution payments. Last but not least, the tail began to wag the dog when pension deficits grew large compared to the sponsoring firm's market value.¹²

CURRENT BEST PRACTICES

We begin with the decision of *if or when to de-risk*. In the order of importance, the following considerations matter:

- Plan sponsor's risk tolerance
- Funding ratio
- Market outlook
- Other firm-specific characteristics

Sponsors that do not de-risk the plan are typically taking market risks in the hope that benign market outcomes will help them pay lower future contributions; in exchange, these sponsors must tolerate the risk that adverse market moves will require them to pay higher future contributions. Companies willing to keep

the DB plan open for all employees (thereby accepting growing pension obligations) seem more likely to exhibit high risk tolerance than others. The increasingly common approach of closing the plan for new hires or freezing the plan (or terminating it fully) can be seen as a *symptom* of lesser willingness to shoulder pension risks. In short, an open plan with growing liabilities, a sponsor that is willing to underwrite the risk of extra contributions, and a traditional equity-risk-dominated asset portfolio are conditions that mutually support one another.

In recent years, many U.S. DB plans link their de-risking to the level of the FR through a *glide path*. A recent CIO manager survey reports that the share of plans that have adopted a glide path rose from 26% to 66% between 2011 and 2015.¹³ Typically, an underfunded plan commits to reallocating assets from return-seeking equities to liability-hedging long-duration bonds as the FR improves and approaches 100%. Clichés used to describe the underfunded plan's situation include "you cannot afford not to take risk" or "you must climb out of the hole." The sponsor may have decided to de-risk but is waiting for a more opportune time, hoping that market developments first improve the FR. The use of such a pre-commitment vehicle while delaying action today echoes the youthful St. Augustine's prayer "to become chaste, but not quite yet."¹⁴

The typical glide path shape may reflect a strong view by management that bond yields will rise (which would reduce the value of liabilities), even more than it reflects a higher risk tolerance at low FR levels. With bond yields near generational lows, many investors view the discount rate outlook in the coming years as asymmetric and warranting persistent duration underweights, notwithstanding past losses in such positions.¹⁵ One counterargument is that there is *limited capacity in LDI assets*: If rising yields prompt many pension plans to de-risk (following the glide path), there may not be enough long-dated bonds available to satisfy this demand, which could in turn cap the yield rises.

Firm characteristics that determine whether one plan is more likely to de-risk than another include the firm's industry and the size of its pension deficit compared to its core business.

- Plan sponsor firms should ideally view pension deficits as part of enterprise risk management. A firm faces more risk when the pension plan

FR is positively correlated with the sponsor's core business than when it is uncorrelated or negatively correlated. In 2008, we saw the triple-whammy that firms can experience when pension assets are down, liability value is up, and the operating business is bleeding cash. This is the ultimate tail-risk scenario that plan sponsors should arguably worry about the most. Through this lens, typical pension plan risks (long equities, short duration) compound the operational risks of firms in cyclical industries, while they naturally hedge many financial intermediaries and other firms that appear to have a long duration. The former group should wish to de-risk its pension plan risk sooner than the latter, all else equal.

- Firm-specific characteristics often determine the aspect of pensions on which management focuses. Actual contribution needs and/or earnings effects are often bigger concerns than balance sheet volatility. For cash-starved firms, coming up with the cash outlay to fund contributions is a challenge, and de-risking is not a feasible option. For financially strong companies, accounting earnings often matter more, and these are influenced by pension expenses.¹⁶

De-risking does not need to imply plan closing. However, it seems that de-risking appears to be more common for a sponsor with a plan that is frozen (or closed to new hires) and has FR near or above 100%, whereas a sponsor with FR between 80% and 90% may keep an equity-heavy portfolio, especially if the plan is open and/or if current interest rate levels are deemed abnormally low (and expected to correct higher). The latter logic represents the situation for many underfunded pension plans and explains the popularity of the glide path approach.

CHALLENGES FACING AN UNDERFUNDED PLAN

Sponsors of underfunded plans often pay only the required contributions and hope that rallying equity markets (growing pension assets) and/or rising discount rates (falling liability values) will close the deficit and allow possible de-risking once full funding is reached—or nearer it, implying smaller contributions. The glide path approach involves delaying the de-risking but

starting it before the full funding is reached—and may involve re-risking if the FR deteriorates.

Delaying de-risking exposes pension plans to *downside risk* that should not be ignored. By trying to climb out of a hole through large equity allocations and duration underweights, an underfunded plan faces the risk of getting into an even bigger hole. That is what it means to take risk with the pension surplus or deficit, as opposed to being fully hedged; the FR could get worse instead of better.

- Corporate DB plans in the United States do not face minimum funding requirements as strict as those in some European countries, where underfunded plans may be forced to de-risk at low FR levels to ensure at least some floor level of pension benefits.
- Nonetheless, the U.S. plan sponsor's situation is asymmetric in several ways. Despite the existence of the PBGC, worst-case scenarios are very painful. Some firms may pay extra contributions to stay above certain trigger levels (say, FR 80%). Improving the FR from 80%–90% up to 100% is highly beneficial, but FR improvements beyond 100% provide less benefit.¹⁷
- One reasonable approach is then to use *options* to reduce upside and protect downside, a potentially costless way to reduce FR volatility. For example, equity index calls could be sold so that they remove upside beyond 105% FR, and the proceeds could be used to buy equity index puts or interest rate floors, which make it less likely that the FR will fall below 80%.

Decisions to de-risk the asset–liability (A–L) portfolio and to pay extra contributions that reduce the underfunding are distinct but may go hand in hand. Paying *some* contributions beyond the minimum to raise the FR (but not to 100%), while not de-risking, can still make sense. Higher contributions have several benefits: they boost reported earnings (given the relatively high assumed returns on pension assets); they are tax deductible; they reduce the variable PBGC premium payments; and they help the plan avoid benefit restrictions (e.g., against paying full lump-sum benefits if the FR falls below 80% on PPA basis). Some sponsoring firms might even consider taking advantage of low yields and *issue long-term debt* to cover the

underfunding (which would reduce the PBGC payments, among other benefits), but this requires taking a broader view of the whole corporate balance sheet beyond the pension plan.

The A-L portfolio is exposed to two main risks: interest rate risk and equity risk. The plan sponsor's market views may determine whether it de-risks one or the other or both; these are distinct choices.

- Reducing the interest rate risk often involves using interest rate derivatives to match the long duration (10–20 years) of liabilities.
- Reducing the equity risk involves switching from equities to lower-yielding bonds or to illiquid assets or liquid alternative strategies that may still offer high expected returns but less equity risk concentration.
- For underfunded plans without a strong rate view, the ideal investment solution combines hedging the liability (at least the duration, using interest rate derivatives)¹⁸ while still earning a high return on assets so as to help close the deficit. The need to earn high asset returns is greater for plans with a lower FR and earlier payouts (which tend to drag FR lower over time).¹⁹
- Equities were long the primary candidate for the high-return asset, but pension plans have been increasingly looking into either illiquid alternatives or broadly diversified composites of alpha and beta strategies to aid in this challenge. The latter should offer higher risk-adjusted returns than equities and less downside risk for the FR.
- De-risking even one of the two main risks makes it more challenging to close the underfunding. De-risking both can lead to a stall situation where contributions must rise each year to cover growing obligations. Leibowitz and Bova [2015a] analyze a typical DB fund (with 80% FR, 55%/45% risky-asset/fixed-income split in the asset portfolio, and half-hedged liability duration) and show that even with very benign market developments—a 250 basis point rise in the discount rate and a 10% annual risky-asset return—it would take five years for the FR to recover from 80% to 100%, assuming no additional contributions beyond liability growth. Stronger de-risking or less benign market developments would make the recovery period longer, easily exceeding a decade.

ENDGAME FOR A (NEAR) FULLY FUNDED PLAN

A number of DB plan sponsors today are looking for the opportunity to remove the pension liability from their balance sheet. This could be achieved by a buy-out and/or by a lump-sum payment to plan members. In a buy-out, a pension plan's liabilities are transferred to an insurance company using a bulk annuity contract, terminating the sponsor's obligation to provide pension benefits. Another possibility is to reduce risks sharply but leave the liabilities with the pension plan after a "buy-in" with an insurance company or a "do-it-yourself buy-in" using capital market solutions, such as interest rate and longevity swaps.²⁰

If the ultimate goal is to sell the plan liabilities to a third party, the first piece of bad news is that projected pension obligations are not certain (on top of the more obvious uncertainty around discount rates and asset values). If plans are not frozen, projections regarding wage growth, early retirements, and other factors may need to be revised. Even for closed plans, projections about longevity may change, and the rules of the game may change (e.g., recall recent increases in pension insurance premiums).

The second piece of bad news is that being fully funded on some measures does not suffice for a full termination of the plan. The FR needs to exceed 100% quite meaningfully, perhaps by as much as 20% on PPA/MAP-21 basis. Recall that this approach values liabilities using an artificially high, smoothed discount rate (recently 7% in Exhibit 3) rather than the GAAP-based discount rate (which uses the current long-dated corporate yields near 4% without smoothing). Any buyouts or other market-based transactions would be valued at current yields and not at historical averages. The difference between 4% and 7% discount rates means that for a plan to achieve 100% FR on a GAAP basis (current market yields), its FR must be near 110% on a PPA/MAP-21 basis.

Another reason that full termination requires FRs above 100% is that there should be some margin for the insurance company (which would only buy the liabilities if it expects to make a long-run profit from the transaction and may want to discount the liabilities at a lower rate than the corporate bond yield), as well as additional costs to advisors, etc. The all-in cost may easily amount to 5% of liabilities or more.

The LDI endgame requires thoughtful cost–benefit analysis about how much to de–risk—fully, partially, or not at all—and an ultimate decision about whether to remove the pension liability fully from the sponsor’s balance sheet. Given that the later steps tend to be more expensive, one reasonable piece of advice is not to deal with secondary risks before the primary equity market and duration mismatch risks have been meaningfully reduced.²¹ These secondary risks include longevity risks, inflation risks (if the plan is not fully frozen), credit risks, and cash flow risks beyond the duration mismatch. These risks are not insignificant, but while keeping the two main risks open often implies a double–digit tracking error against liabilities, the secondary risks give rise to tracking errors in single digits, which may be sufficiently low for some plans.

APPENDIX A

BACKGROUND ON U.S. CORPORATE DB PLANS: KEY CONCEPTS AND TERMINOLOGY

DB versus DC plans: A U.S. corporate DB plan promises defined retirement benefits to participating employees according to some formula (often tied to the salary in the final working years and the number of working years). The investment risk and longevity risk rest with the plan sponsor, which may need to make additional contributions if initial contributions and investment returns (including revised liability estimates) result in underfunding. This one–sided risk–sharing has been one major motivation for firms to shift from DB plans to DC plans, effectively passing the investment and longevity risks to the employees.

Plan openness: DB plans can be open to all employees—with obligations growing with rising benefits and new hires—but many plans have closed these plans to new hires, instead offering them DC plans. In existing DB plans, some sponsors have frozen the plan (stopping the growth of liabilities with wages). In the extreme, sponsors may terminate a plan.

Liability measures: The most important concept is the present value of PBO, which includes both accumulated benefit obligations (ABO) and the impact of projected wage growth. The post–retirement benefits in corporate DB plans are typically defined in nominal terms, so the main liability is nominal, but during the working years the liability is also related to inflation and real wage growth.²² PBO may also grow if underlying assumptions (regarding plan members’ expected longevity, or nominal wage growth, or pension insurance contributions, etc.) need to be revised.

Discount rate types: The liability is present–valued using a discount rate that varies depending on the context and has varied over time (both because markets move and because “rules change”). Lower discount rates imply higher values of liabilities (and thus greater chance/depth of underfunding). The Pension Protection Act of 2006 stipulates that U.S. corporate DB plans should determine minimum contribution levels using a discount rate based on the recent level of corporate bond yields, but subsequent legislation has allowed significant smoothing of yields, thereby permitting higher discount rates and lower contributions today. FASB 158 states that these plans should use current market yields of long–term, high–quality corporate bonds (with no smoothing) as the discount rate for pension accounting (GAAP). Many financial economists argue that if pension obligations are riskless, they should be discounted with Treasury yields, and that the true economic value of the pension liability is unaffected by accounting choices or even by investment strategies (see note 10 as well as Waring [2011]).

Terminology on pension fund balance sheet: The market value of pension plan assets reflects the cumulative sponsor contributions and the investment returns earned on them (minus benefits paid out). The present value of projected plan liabilities is the PBO (see previous discussion on discount rates used). The difference between the market value of plan assets and the present value of plan liabilities is the plan surplus ($S = A - L$; may be called deficit if it is negative). The corresponding ratio of the value of assets over liabilities is called the funding ratio ($FR = A/L$; also called the funded status). When assets exceed/equal/lag liabilities in value (i.e., $FR >/=/< 100$), the plan is called overfunded/fully funded/underfunded.

Approaches to pension asset management: Two extreme approaches to managing these assets are assets–only (maximizing expected returns subject to portfolio volatility but ignoring liabilities) and liabilities–only (matching assets to liabilities as well as possible, irrespective of expected return). More realistic intermediate approaches include contribution management and surplus management. Contribution management focuses on the trade–off between expected contributions (higher equity allocations imply lower average contributions) against contribution uncertainty (higher bond allocations imply more stable contributions). Surplus management focuses on the surplus ($A-L$) or the funding ratio (A/L). In this approach, FR volatility is seen as a key risk and long–duration bonds (rather than cash) are the lowest–risk assets or best liability hedges.

Major risks: A key characteristic of DB plans is that the plan sponsor bears the investment risk and longevity risk and will have to make further contributions if needed.²³ Funding ratio volatility (or surplus volatility) is a good summary measure of a pension plan’s overall short–term risk.

Falling equity markets and falling bond yields can make the plan underfunded and require further contributions and in the very worst case might challenge the plan solvency. Equity market risk dominates the asset side of most pension plans, while interest rate risk dominates the liability side, especially because pension liabilities often have very long duration. Corporate bond rates are used as the discount rate, but it is not easy to find investable bonds that would match the liability duration, let alone expected cash flows. Longevity risk is also important, and changes in mortality assumptions are difficult to hedge. In addition, open plans are subject to uncertainty in projected wage growth that is related to inflation and real growth. Equity allocations have been motivated by their long-run ability to hedge real wage growth and, even more, by the equity premium which should help reduce expected contributions. Without equities, there is a long-run risk of unacceptably low plan returns and thus high contributions.

APPENDIX B

THE SHIFT FROM DB PLANS TO DC PLANS

U.S. corporate pension plan sponsors have over time become less willing to underwrite the risk of rising pension contributions, resulting in a trend from DB plans to DC plans. Let's start with some numbers.

- The shift from DB plans to DC plans began in the 1980s. Federal Reserve's Flow of Funds data show that the share of DC plan assets among private pensions rose from 24% to 63% between 1975 and 2014. Towers Watson finds that 60% of Fortune 500 companies offered some type of DB plan to new hires at the end of 1998, but this ratio fell to 24% by the end of 2013. (However, nearly half of Fortune 500 companies that no longer provide DB benefits to new hires still have active employees who are accruing benefits.) More recently, *CIO* magazine's LDI survey (2015) shows that when CIOs were asked about their current plan status, the response "Open to new entrants and accruals" fell from 68% to 47% between 2011 and 2015, and when asked about the endgame plan, the response "Keep plan open and maintain" fell from 65% to 47%.²⁴
- Within DB plans, there have been notable asset allocation shifts during the past decade. The Milliman Top 100 DB plans had equity/bond/other weights 61%/29%/10% at the end of 2005 but 37%/43%/20% at the end of 2014. Recent *CIO* magazine surveys report growing use of derivatives (from 45% to 70%) and some form of LDI (from 52% to 77%) since 2011.

There are many explanations for sponsors shifting from offering DB plans to offering DC plans.²⁵

- In the 1980s and '90s, some large pension insolvencies led to tougher funding requirements as well as an excise tax on employers who reclaim assets of terminated DB plans. Less stable firm finances and the changing nature of the labor force, away from life-long careers with one company, made many firms move away from DB plans as a tool of personnel management (as DC plans offered more portability for employees).
- Apart from the workforce aging, expansions to the mandated forms of benefits added to the cost of providing a DB plan. Lower interest rates as well as greater longevity and pension insurance premiums boosted the liabilities. All these developments made pension obligations grow in comparison to many sponsoring firms' core business.
- Adverse equity market moves and discount rate changes in the 2000s required employers to nearly triple their annual pension contributions and still coincided with a shift from overfunding to underfunding in many plans. Accounting and regulatory changes made the fluctuations in funding ratios more volatile and more visible. DC plans shifted investment risk and longevity risk to plan participants.
- DB plans are by no means only a cost. They can offer a competitive edge in attracting and retaining skilled workers, given a growing appreciation that DB plans offer safer retirement income than DC plans. They also offer some tax and accounting benefits. Another key virtue in DB is the convenience and cost-efficiency of the sponsor taking care of most steps in accumulating, investing, and decumulating retirement savings, including efficient pooling of longevity risks. However, for many sponsors these benefits appear to have been overwhelmed by the costs and risks noted earlier.

ENDNOTES

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investor's own view on the topic discussed herein. Past performance is not a guarantee of future results.

¹See Ehrhardt et al. [2015].

²The term bond “duration” measures the sensitivity of a bond or a portfolio to changes in interest rates, and it is closely related to the present-value weighted average maturity of the bond’s cash flows. For example, a duration of 5 implies that the portfolio would rise by roughly 5% given a 1% fall in yields. A DB fund liability value might have a duration of 12, so that such a liability value would be more sensitive to falling yields than an asset portfolio with lower net duration. An asset portfolio with a higher duration would thus provide a better hedge against falling rates. The hedge ratio between asset and liability interest rate risks depends on both the relative durations and the relative sizes of assets and liabilities. Duration underweight refers to the common situation where this hedge ratio is below 1 and falling yields hurt the FR.

³See Ehrhardt et al. [2015] and aiCIO (<http://www.ai-cio.com/2015-Liability-Driven-Investment-Survey/>).

⁴Our analysis is unabashedly U.S.-centric but certain patterns and findings apply well to DB plans outside the U.S. The story, or aspects of it, has been told many times; see, for example, Bader and Gold [2003]; Waring [2011]; Ryan [2013]; Ellis, Mundell, and Eschtruth [2014]; and Siegel [2015]. For a treatment on combining asset-only perspective and asset-liability surplus perspective, see Leibowitz, Kogelman, and Bader [1992a].

⁵See Ehrhardt et al. [2015].

⁶Liabilities are proxied by the Citigroup Pension Liability Index, which represents Aa/AA rated long-duration corporate bonds (the index duration has risen from 14 years in the mid-1990s to 19 years recently). Assets are proxied by a portfolio of stocks/corporate bonds/alternatives (real estate, private equity, hedge funds) with 60%/30%/10% weights before 2008, 55%/33%/12% weights in 2008, and 45%/40%/15% weights after 2008, broadly in line with the asset class weights in the Milliman Top 100. (The specific indices used are: half S&P500, half MSCI World for stocks; half Barclays US Long Corporate Bonds index, half Citigroup Pension Liability index for bonds; half NAREIT all REITs index, half NCREIF Property Index for real estate; half Cambridge Associates US Private Equity index, half 1.3-times levered Russell 3000 index for private equity; and the HFRI fund-weighted composite index for hedge funds.) These proxy series are only based on market moves (without smoothing) and thus ignore changes in projected pension benefit and contribution values (these two are assumed to offset each other in the evolving FR). The FR is assumed to be 100% at the end of 1994. The proxy series in Exhibit 2 are broadly similar to those of the Milliman Top 100 index in Ehrhardt et al. [2015], but the latter series only begin in 2000 and are annual.

⁷Before FASB 158, accounting discount rates were tied to corporate bond yields but could be offset by other items related to the assumed expected asset returns, and the market-based funded status only needed to be reported in notes (not in the balance sheet). After FASB 158, there was some flexibility in the specific choice of rates, but they needed to be current high-quality corporate yields. While balance sheet accounting for single-employer plans is now market based, the income statement for pension expenses remains influenced by the assumed expected asset returns. FASB has hinted that this may change in the future and bring the U.S. in line with international accounting standards (IAS 519); such a change would make earnings more volatile. Public plans, church plans, and multi-employer pension plans still use assumed expected asset returns to discount liabilities.

⁸The calculation mechanisms in MAP-21 and HATFA were pretty complicated, but the implementation details are not important, the impact is. Effectively, the smoothing in these laws allowed corporations to temporarily use a higher discount rate, thereby report smaller underfunding, and thus pay lower contributions now. But the relief “now” inevitably came at the expense of higher contributions “later” unless fortuitous developments in capital markets (rising bond yields, rising equity markets) would offset the need. Note that delaying contributions seemed preferable both to those corporations with low cash balances and to the legislators hungry for high near-term tax revenues (pension contributions can be deducted from a firm’s taxable income; thus, higher contributions today imply lower corporate tax intake today).

⁹The insurance premiums DB plans must pay to the PBGC are one side of the coin. The flip side is that if a plan sponsor firm is unable to pay the plan participants, the PBGC will come to help. This feature is sometimes called “the pension put,” as if the plan sponsor had the option, in a case of company default, to “put” the pension liability to the PBGC. Such a put option is claimed to induce excessive risk-taking, but let us not exaggerate: the default scenario is so painful for the firm that nobody seeks it. The protection for plan participants is also not complete as the benefits the PBGC pays have certain dollar caps (approx. \$60 thousand). Finally, PPA 2006 tried to contain any incentive for excessive risk-taking by mandating plans to cover any underfunding by contributions (over a seven-year period) and by imposing benefit restrictions at certain FR levels (e.g., if FR falls below 80, new benefit increases are largely precluded), besides the variable premiums rising with underfunding as noted previously.

¹⁰We do not focus on the debate about the “correct” discount rate. Briefly, many financial economists argue that any riskless liability should be discounted with a Treasury rate, while the traditional actuarial approach is to discount liabilities with the assumed expected return on assets. (In between these extremes are discount rates based on corporate bond

yields, either current or smoothed, as allowed by regulations.) One way to reconcile the two extreme discount rates is to say that they address different questions. The riskless rate is appropriate if a sponsor asks how much it should invest in Treasuries to fully guarantee (defease) the present value of its pension liability. In contrast, the “expected return approach” asks what level of assets is needed to cover 100% of future liabilities. Critics (such as Waring [2011]) stress that the latter approach ignores risk. Risky assets of course do have an expected return advantage over long horizons, but their edge is not riskless, leaving open the risk that assets will eventually prove insufficient to cover liabilities, requiring further contributions from the sponsor or ultimately from future taxpayers. (Financial analysts have long tried to quantify the impact of a mismatch between risky pension assets and putatively riskless pension liabilities; for an early treatment, see the concept of risk-adjusted surplus in Leibowitz, Kogelman, and Bader [1992b]. One issue relating to the use of riskless discount rates is that even the liabilities are noisy (especially for open plans); for a discussion on asset allocation amid uncertain liabilities, see Leibowitz, Kogelman, and Bader [1992c].)

¹¹In the 2015 aiCIO LDI Survey, the average FR on GAAP basis was 91%, while that on PPA basis was 89% and that on PPA/MAP-21 basis was 101%.

¹²See Munnell-Sass [2006].

¹³See aiCIO, 2015 Liability-Driven Investment Survey (<http://www.ai-cio.com/2015-Liability-Driven-Investment-Survey/>).

¹⁴Incidentally, the risk tolerance pattern represented in the glide path is not the only possible way risk-taking attitudes can vary with the FR level. For example, Dutch and some Scandinavian funds are required to de-risk as their FR deteriorates (to ensure that pension obligations will be fully covered); see Leibowitz and Bova [2014].

¹⁵So far bond-bearish predictions have not panned out well. For over a decade, many plans have given their asset side much lower interest rate sensitivity than their liability side, and this duration mismatch proved costly as bond yields trended lower.

¹⁶The accounting “arbitrage” between expected return on assets and the (GAAP-based) discount rate on liabilities—currently about 7.5% and 4%, respectively (see Ehrhardt et al. [2015])—implies today a 3.5% benefit that boosts reported earnings. This also means that de-risking is a two-edged sword when a larger bond weight reduces expected asset returns and thus raises the pension expense. Some companies have moved to mark-to-market pension accounting (resulting in more transparency, more volatility) but then may encourage analysts to focus on non-GAAP earnings (excluding pension expense). Some financial economists emphasize that such choices have no impact on the economic pension liability.

¹⁷Again it matters which FR we are talking about. Having FR 100% on PPA/MAP-21 basis would not yet allow

the sponsor to remove the pension liability from the balance sheet without costs. Recall that this FR may correspond to FR near 90% on the more conservative GAAP basis.

¹⁸For an underfunded plan, the value of assets is below the value of liabilities, and only a subset of assets is in fixed income. Moreover, it is difficult to construct a portfolio of corporate funds that matches the very long duration of liabilities. Thus, hedging the interest rate risk in a corporate balance sheet often requires interest rate derivatives. An ancillary benefit of using them is that they require more limited cash (for margins) so that the remainder may still need to be invested in high-returning assets.

¹⁹Leibowitz and Bova [2015b] show that the FR is not a comprehensive gauge of fund status. For underfunded plans, the payout structure matters beyond the present value of liabilities because early payouts cause larger percentage declines for assets than for liabilities. The required asset return that would fully fund (or “fulfill”) a given liability over a given horizon, without any future contributions, will be higher for plans with a lower FR, higher discount rate for liabilities, and earlier payouts.

²⁰A buy-out involves buying a bulk annuity contract from an insurance company in order to fully terminate the plan. In contrast, a buy-in involves buying a bulk annuity contract with an insurance company as an investment to match some or all of a pension plan’s liabilities. While a buy-in reduces the plan’s risk, the liabilities still remain in the pension plan and the trustees retain responsibility for them. A buy-in is less costly than a buy-out, while capital market solutions may offer an even more cost-effective way of de-risking.

²¹Partial buyouts, where only the retiree portion of plan liabilities is sold to an insurance company, may be an expensive way to reduce plan risk, despite their increasing popularity. NISA [2015] argues that removing most of the two main asset class risks through a “hibernation” strategy can bring the FR volatility to low levels (1%–4%) at much lower cost. For more on the hibernation strategy, see NISA [2013]. Full termination gives a cleaner break, by eliminating all market risk and longevity risk as well as ongoing plan costs.

²²For a discussion of dual duration of pension liabilities (inflation and real rate durations), see Waring [2004].

²³Vested employees in DB plans have the now-enviable benefit of lifetime nominal income streams after retirement. The main risks these employees face are inflation risk after retirement as well as the sponsor’s inability to pay—partly protected by funding regulations and the PBGC insurance. In DC plans, employees also face investment and longevity risks.

²⁴See Towers Watson (<http://www.towerswatson.com/en-US/Press/2014/09/retirement-plan-landscape-stabilizing-as-fewer-fortune500-companies-shift-defined-benefit-to-401ks>) and aiCIO (<http://www.ai-cio.com/2015-Liability-Driven-Investment-Survey/>).

²⁵See Ellis, Munnell, and Eschtruth [2014]; Siegel [2015]; and Waring [2011].

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